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ABSTRACT

This document provides nine papers presented at a 2-day conference where representatives of the National Aeronautics and Space Administration (NASA) described the future of space exploration and discussed the implications of that future for educators. The proceedings begins with an introduction by Ralph Winrich, NASA Aerospace Education Specialist, and a welcome by Andrew Stofan, Director of the Lewis Research Center. Papers from the first-day session include the following: "Beyond the Space Station--the Long-Range Future" (Jesco von Puttkamer); "No Fuel Like an Old Fuel" (William Higginson); "Computer Graphics" (Peter F. Demers); "Linkage between NASA and Schools" (R. Lynn Bondurant); and "Surfing the Third Wave" (Richard Byrne). A second day welcome by Omar Olson, President of Lorain County Community College (LCCC), is followed by "Education and the Communications Revolution" (Richard Byrne); "Biotechnologies--A Quick Introduction" (Jean Marx); "High Technologies at LCCC" (Dallas Garrett); and "Where Can the Interaction between High Technology and Education Take Us in the Future?" (Allan McLeod). A list of participating organizations, notes on the conference sponsors, and a list of the steering committee is included. (LMM)

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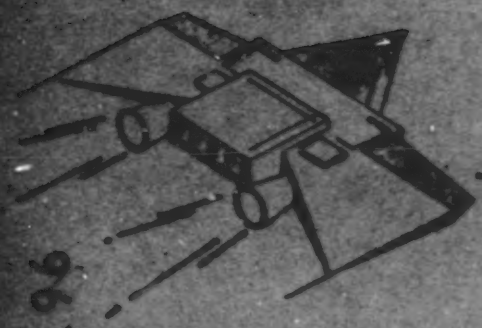

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FUELING THE EDUCATION EXPLOSION

PROCEEDINGS
OF
CONFERENCE 4

HIGH TECHNOLOGY and EDUCATION

September 20-21, 1984
Cleveland, Ohio

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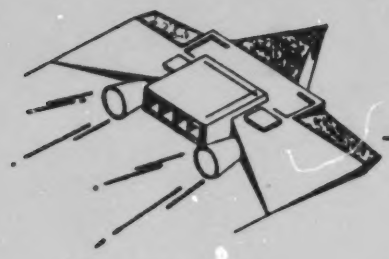

FUELING THE EDUCATION EXPLOSION

BACKGROUND

The FEE Organization (Fueling the Education Explosion) is a non-profit coalition of volunteers and sponsors whose purpose is to assist Ohio youth in the future.

The project is designed to address the fact that the pace and types of change in our society have created a unique opportunity for public schools to take the lead in determining how to educate children for the future. As we face the prospect that many educational practices and programs are failing to meet the needs of today and tomorrow, there is room for optimism about meeting the challenges of change.

The FEE conference topics are planned to help us understand what the future will be so that we can anticipate and shape the changes. As school and community leaders, we can begin to see ourselves developing and determining what the trends in education should be in 5 years, 15 years, and into the 21st century.

Important ingredients for achieving the project's goals are: current information and knowledge from recognized thinkers, futurists, inventors, communicators, scientists and educators; planning techniques and strategies that include creative/productive thinking; and networking, so that each district can become a resource for the whole group.

Most important and necessary to the project are the participants. The design calls for teams to represent a school district or other organization. For example, a school district is encouraged to send a team of three to five members, who might include the following: superintendent, school board member, principal, teacher and community representative.

These teams operate in various ways. During conferences, small groups composed of three to five teams focus their planning efforts on common needs, goals or problems. Each group has a leader and a recorder trained specifically to help participants use the problem-solving and inventive reasoning methods in the project model.

Between conferences there is a continuing exchange of information and support among the school district teams regarding the progress, success and failure of their specific projects. Dissemination and networking are enhanced by the published proceedings of each conference.

Participants are encouraged to evaluate all parts of each conference and to give suggestions for additional topics to be addressed though the project.

The first conference, "Ignition!", was held on May 5 and 6, 1983, and was attended by 200 representatives of school districts and communities throughout Ohio. Costs were underwritten by sponsors who provided sites and facilities, by volunteers who donated planning and implementation time, and by the fees paid by participants. Costs of preparing and disseminating the conference publication were underwritten by The Standard Oil Company (Ohio) and The Martha Holden Jennings Foundation.

Conference 2, "Intelligence and Schooling", was held November 17 and 18, 1983 at Cleveland State University. The three major topics were real-world intelligence, artificial intelligence, and linkages between the education and corporate sectors.

On March 29 and 30, 1984 at Conference 3, "Career Opportunities for the Future", conferees heard forecasts of jobs in the 1990s and into the 21st century. A panel of executives in health care, industry, technology, engineering and entrepreneurship discussed current and future employment in their respective fields. And representatives of Governor Richard F. Celeste outlined the "strategic plan" for putting Ohioans back to work.

Conference 4, "High Technology and Education", was held September 20 and 21, 1984. This exciting conference included demonstrations of computers and robotics, satellites and communications, and biotechnologies and lasers. Conferees heard representatives of NASA describe the future of space exploration and discuss the implications of that future for educators.

The concluding conference in the series will be held May 2 and 3, 1985, and will call for conference participants to share the impact of the FEE project on their school systems or organizations. This "Networking and Sharing" Conference will feature paired speakers -- an "expert" paired with a past FEE participant who has put into practice what the conferences have advocated.

Proceedings of Conferences 1, 2, 3 and 4 are available for $5 each.

RALPH WINRICH

The title I carry is Aerospace Education Specialist. That's a pretty long title. Generally, I refer to myself as an educator with an emphasis on aerospace education. Out of NASA's Lewis Center we service schools in the states of Wisconsin, Minnesota, Michigan, Indiana and Ohio. That area covers about 21 percent of the nation's population and there are two of us to cover this territory. So there are a lot of schools we don't get a chance to visit. For many outlying areas, like Minnesota and my state of Wisconsin, I'm the only contact that these people have with the space program. In the four years that I've been doing programs such as this, I have seen the equivalent population of the city of Cleveland and most of its suburbs, and if you throw in radio and TV contacts I've come fairly close to five percent of the nation's population.

A lot of the people I talk to have some strange conceptions of the space program. There's a lot of interest, but there are little isolated pockets of hostility. I can count on at least once a month finding a school administrator who feels that the space program is a waste of money. Now I don't know if there's a correllation here, but when I find that, I usually find an administrator in an outlying community who belongs to two bowling leagues and can tell you what the latest TV series is doing on three different networks. Something I'm sure we don't have to worry about here. But education in the midwest is really a hodge-podge of different areas and personalities and methods.

Ralph Winrich

We cover a variety of subjects: usually I start out by talking about NASA's research in aviation, and then I move into the space program and problem-solving and we end up talking about the planets and so on. Now NASA's research in aviation has a variety of goals in mind. Among these are to reduce the cost of flying, increase aircraft efficiency and increase aircraft safety, and as a result, there are a lot of different airplanes we've been working on. The model plane I'm holding -- a modified DC-9 -- does not exist. The model comes courtesy of McDonnell Douglas and the propeller design is something that Lewis has worked on. And eight- or ten-bladed configuration is fuel-efficient and competitive with jets. This kind of an aircraft can fly as high as a jet and as fast as a jet, and use 25 to 30 percent less fuel. In addition, it's very quiet on take-off. So if you live next to an airport and they have this kind of aircraft taking off, you'll be thankful.

NASA has done some testing of aircraft for the military over the years and come out with an airplane that makes people remark on first sight, "That's kind of spiffy. What will it do?" It's called HIMAT -- Highly Maneuverable Aircraft Technology -- and it represents a whole new type of aircraft technology. This particular plane is capable of making some incredible turns, which is useful because military planes have a habit of shooting at other military planes. And the easiest way to down a jet is to launch a heat-sensing rocket that goes up the exhaust pipe and blows the plane apart. That would be more difficult with a plane this maneuverable. This plane is capable of either turning around and defending itself on direct assault, or confusing -- going up and coming behind the object tracking it. There is a problem with that. The aircraft can do it but the pilot can't. If you were sitting inside this thing and you made such a turn, the g-load would be so high you'd pass out. How can you fly an airplane when you're suddenly sound asleep? So this plane is flown by a pilot on the ground -- totally remote control. We finished our end of the research on that, and turned this project over to the military.

The U.S. space program and NASA were founded because of a desire to catch up. On October 4, 1957, we found that the earth suddenly had an artificial satellite. And it wasn't ours. Several weeks later, an attempt to launch an American satellite failed -- it went about two feet. This was broadcast on public television and it was somewhat embarrassing to this country. The space race had begun. After NASA was founded a series of successful rocket launches occurred and we moved into the manned space program. There's one sure lesson in launching a rocket into orbit -- a 99 percent success is a failure. You have to be 100 percent on the money.

The first manned space program began with an Atlas rocket and a Mercury capsule. The goal of Project Mercury was simply to put one man into space, keep him alive, and bring him back in once piece. Now a Mercury capsule does not have a lot of room in it. A Mercury astronaut was strapped into a seat and once in space they could move their hands to flip a variety of switches; they could hold up a camera and take photographs out a viewing port not much bigger than my fist; they could stretch their legs and wiggle their toes. That's it. They did not get out of their seat and experience weightlessness like the astronauts do now. The longest flight in Project Mercury was slightly over one day, but imagine that -- sitting in a locked position for a full day.

If that sounds uncomfortable, Project Gemini was a little bit more so. For Gemini, NASA doubled the size of the capsule but added two personnel. So they sat side by side in a capsule that allowed them the freedom only to move their arms, stretch their legs, and hold a camera up to take pictures out of a window. One of those flights lasted 14 days. Imagine sitting where you are now for two weeks. When you sit for that long, you hope the person sitting next to you is somebody you get along with. We had to consider compatibility.

We use scale models when we do school programs to give the students an idea of how large the launch vehicles were, especially when we move into Project Apollo. Project Apollo used the largest rocket ever

built -- the Saturn V. This was a very complex piece of machinery that stood 363 feet tall and weighed over 6,400,000 pounds. That's longer than a football field and it produced horsepower equivalent to half the cars in the State of Ohio driving at a normal speed. The Saturn V rockets were good for one launch. The capsule was the only returnable item on such a flight, and that's a very small return. All the rest of it comes apart: parts of it were crashed on the moon, parts of it were dumped into the ocean, and parts of it re-entered the atmosphere and burned up. The three-man Apollo capsule was the only part that made the whole trip. And because of the heat of friction upon re-entry and the special heat shield on this, the capsule only landed once. By the time we fished this out of the ocean, it was only good for a museum. Does that make sense? Any economists in the audience? Isn't that an expensive way to travel? What if your school used a bus to take a field trip and for the next field trip they had to buy another bus? That's what NASA was locked into. That's why the shuttle program came along: to build a reuseable piece of space equipment.

Now in the early days we had a lot of different ideas. One early shuttle design was called a lifting body. There's only one thing wrong with this specific design: it doesn't work. It should do three things: it's supposed to go up like a rocket, and with a booster we could do that; once it's in space it's supposed to fly like a spacecraft, and that would happen. (In fact, we could put the new backpack on and you could become a satellite.) Then it's supposed to de-orbit, come down and land like an airplane. The lifting body comes down like a brick. We tested several different variations and we actually did succeed in landing some, but they were extremely awkward and quite small. If this was our space shuttle, we would be limited basically to what we had in Apollo -- a three-person crew and a cargo capacity of several tons. What we've got now is considerably larger.

If we could bring Discovery and park it out in front of your school you couldn't miss it. The tail is six stories high. And in the launching position, you're looking at 12 stories of rocket. It's about

the size of a DC-3 or so. The cargo bay is 60 feet long and 15 feet wide. We could put a school bus in there and you could park your station wagon right in front of it: ten minutes and 20 seconds later we could have it 160 miles high and 250 miles down range. Then when we open the doors and give it a little kick, you've just placed a school bus into orbit. That may sound absurd, but we actually had somebody in Massachusetts request that NASA put a '57 Chevy into orbit.

Now, in the human aspect of space travel, there are certain needs that we humans have: things like oxygen, food supplies, a change of clothing now and then, a place to sleep, and preferably a lavatory of sorts. In the space program, food was changed a lot over the years. I think a lot of you would pass up what an astronaut had to eat back in the days of Project Mercury. A lot of food items came in hard packages and you had to inject water into the package. There was a hose in the reservoir and a nozzle. The astronauts had to add about six ounces of lukewarm water, reseal it, and knead the package -- squeeze it for three or four minutes so that everything was all mixed up. Then they'd unfold the end, put it in their mouth and squeeze the food right up the tube. Just like eating baby food.

For some reason they didn't like that. So we kept the method the same but we improved the quality, the color and the texture. We went to spoon packages, such as this chicken stew package which has actually been to the moon and back. This has got over two million miles on it. There's chicken, gravy, peas and carrots. So you'd inject three ounces of hot water and reseal the package. If you squeeze this kind of package you'll end up with the baby food again. You might rap it against your hand, you might wave it around a little bit, and you have to wait about five minutes, so you just let go. It'll float in front of you. When it's time to eat this kind of a package item, you have to be very careful. You pull the two tabs up on the top, it opens, you cradle it, bring it in very close, you fill the spoon and slowly bring it up to your mouth. No

problem. Unless of course you stop the spoon once you've started it, because only the spoon will stop; the food will keep right on coming. That limits the kinds of foods you can take.

We tried a lot of different items and found some of them work better than others. A common breakfast food item is corn flakes with sugar and powdered milk added. Inject cold water, open it up and eat. Try that with Rice Krispies sometime. When you open it up, they escape, and you have hundreds of soggy little Krispy Kritters floating all over the place. That happened once on Skylab, and they were combing those things out for days. They also found out on Skylab that spaghetti becomes unappetizing because the noodles look like they're alive. Some things are dangerous if they're out on their own. Any liquid can be a hazard. Think of what would happen if water or coffee or Tang got into the electrical switches. So we use a container that keeps liquids sealed.

In the Shuttle program, they've gone to a food tray that keeps everything in its little compartments. A typical breakfast in space consists of two scrambled eggs, one sausage patty, bran flakes, hot chocolate, coffee or tea, a can of fresh fruit and a powdered orange drink that is commercially available. (I get asked a lot of questions about the space program, and number three in the order of questions is: Do they really take that stuff up? Yes, they do: they take a lot of it up and they bring a lot of it back.) A magnet keeps your utensils in front of you and there are clips for extra items like packs of peanuts and your napkins. The tray itself will mount on the wall; the astronauts can mount themselves wherever they want. Some people like to hang from the ceiling, like John Young does; some people like Bob Overmyer prefer to be tucked away in a corner somewhere. Everybody has their own way of doing it.

Now, that's a typical meal in space and after it's over you've got to consider what to do with the dishes and yourself. Because water is a problem, we eliminated such things as a sink, a shower and a bathtub. But

think about the dirty dishes you acquire if you're up there for a week. What about yourself? If you don't take a bath or a shower, nobody's going to talk to you. Not even the people on the ground. So we had to solve these problems. First of all, the dirty dishes. Every food pack gets a chlorine pill, which kills off any bacteria residue. Then the food packs are stashed in a plastic bag. On a one-week flight with a crew of six, you'll come back with three big plastic bags of garbage and as far as I know these things are just thrown away. I doubt anybody wants to save that stuff. Cleaning yourself requires the use of a chemically treated paper towel. After an exercise period, which consists of jogging in space, you give yourself a sponge bath.

One of the more popular misconceptions about the space program is how we brush our teeth. That little exercise in itself can be exhilarating. If you induce a certain kind of a motion to your arm in a weightless environment, you're going to induce motion in the body. You can propel yourself by brushing your teeth. Brushing sideways is a great way to meet the walls. A lot of children have developed the habit of brushing in a circular motion. You can imagine what that could do. We solved that problem by reinventing the toothbrush and modifying the tennis shoe. The tennis shoe has a toe shaped like a pyramid, and it attaches to certain sections of the floor. The bristles of the toothbrush have a built-in paste similar to baking soda, which is edible in small amounts. If you brush with your mouth open, you will have the interesting dilemma of floating materials. When you finish brushing, the brush is thrown away and by adding a little water you can swallow the residue that's left in your mouth.

There are all sorts of reconditioning once an astronaut is back on the ground. You don't want to get into the habit of swallowing your toothpaste at home, and you don't want to get into the habit of releasing items that would normally float in front of you. One astronaut who had spent two months on Skylab attended a luncheon about two weeks after he returned. He was sitting with a lot of distinguished guests including the Governor of Texas, and after drinking from his coffee cup he reached out and released it. He was never asked back again.

There are a variety of ways to sleep in space. One astronaut came up with the idea of sleeping on a string. He took a piece of line and attached alligator clips on both ends, hooked one to his trousers, one to the wall, folded his arms and just kind of hung out. It works. Two people can do that, and you can end up with some interesting situations. One person can have his head here, his feet there, and the other person can have his head there and his feet here. Some people sleep on a couch, some people use our sleep restraints, which are sleeping bags. Variety of ways. Going to the bathroom in space is a little different. You have to wear a seat belt. We have had more than our share of problems with the toilet and I won't go into those.

Going into space has presented us with the need to do a lot of problem solving. For instance, how do you come back to earth. Now with the capsule, you could do that one time. There was a shield on the bottom which went through a process called ablation. It would heat up, it would melt, and it would flow off, taking the heat with it. Now that will work one time, but it leaves the capsule in rather sad shape. Now the shuttle is valued at about a billion dollars, and it would be desirable to use it more than once. So you've got to come up with another method of re-entry.

The method of de-orbiting the shuttle entails its rotation into a nose-down, tail-up position. Then two engines are turned on, each producing about 4000 pounds of thrust and they push against the direction of travel. Before that process, shuttle speed is almost five miles a second. That will take you from Cleveland to the Kennedy Space Center in less than two and a half minutes, or coast to coast in about twelve and a half minutes. After the procedure I just described, you've decreased your speed by about 350 miles an hour. That's still a lot of motion, and it will carry you almost half way around the world. Since you can't land in this position, the vehicle is then rotated to a nose-up, tail-down configuration.

The first contact with the atmosphere is like a belly flop. The air rubs against the bottom and that friction heats the bottom of the vehicle to over two thousand degrees. The shuttle is made out of a lot of steel and aluminum, and at two thousand degrees, that stuff is a liquid and a gas. Without insulation, you've got a billion dollar can of shuttle soup. So we came up with an interesting design using a material that we knew would work back in the fifties: silicon. We've had more than our share of problems with silicon, but it has been improved. The belly of the shuttle is tiled with silicon squares which look and feel like styrofoam, but which are capable of withstanding temperatures over 2000 degrees and then cooling down very quickly. It would make an excellent material in your home. In my area of Milwaukee, which is similar to Cleveland in terms of climate, a one-inch thickness of silicon is all I'd need to insulate the whole house. And if I had a real tight seal in the winter time in a three bedroom home, I could heat that house by placing a couple of candles in each room. One drawback with that -- in this form it's rather expensive. To insulate your home would probably be in the neighborhood of 3/4 of a million dollars. But think of the money you'd save in fuel. There are companies, though, that are looking at using silicon materials in insulations.

Beyond human space flight is the realm of planetary exploration, and we've rewritten the textbooks in the last 25 years. The planet Mercury is no longer the mystery it was; it looks a lot like the moon. Twenty-five years ago a textbook discussion of Venus talked about the possibility of life. We envisioned steaming jungles and oceans and so forth. If you pay a visit to Venus today you're in for four surprises. As your spaceship goes through the clouds, you find out they're not water vapor, but sulfuric acid. Nice stuff. As you get lower and lower it gets warmer and warmer; if you make it to the surface you find the temperature is over 800 degrees. You will also find the atmospheric pressure is 90 times that of the earth's surface, so you're going to be squashed flatter than a picture. And if that's not bad enough, a lot of the gasses at the surface contain such things as nitrous oxide -- better known as laughing gas. So you'll be squashed flatter than a bug, you'll be burnt to a crisp, you'll be slowly dissolved, and you'll love it.

Mars turns out to be rather cold, although we don't know a lot about the surface because we have only landed at two different spots. These are horizons of the future. Other things in the future include space platforms and space station ideas.

This is the kind of research that we've been involved in and these are the things that students are very curious about. And students are interested. Astronaut Judith Resnick, who later got her Ph.D. in the electronics field, wasn't sure in what direction she was going to go, and she really didn't consider the space program when she was in high school. And yet when you talk to today's students, you'll find there are a fair number of them who say that's what they want to do. They've got a good chance. By the year 2000, this country expects to have placed more than 1000 Americans in space. That figure right now is 86. And that means things are going to accelerate tremendously in the next 15 years. Some of your students will one day fly in space.

ANDREW STOFAN

I have a deep interest in support of the educational process, in part because I feel strongly about it and believe in it, and in part because I don't have a choice. My wife is elementary supervisor in the Elyria school system, and her father also was in the profession, so she keeps a very close rein on me and keeps my attention on the educational process. I'm especially interested in science and mathematics education in the school systems of the country. Working with Lynn, we have tried to branch out more and more from the Cleveland area, and we've had teachers going into many states. In fact, we will be going out very shortly to dedicate teachers' resource rooms in several states. My wife taught science in grade school and is very active now in putting together curriculum and in bringing computers into the school system. So I keep in very close touch with what is going on in the school systems around the country today.

I feel strongly that NASA has a unique role to play in education. When my wife was teaching fifth grade science in Fairfax County, Virginia, she told me that any time the class started to get unruly, all she had to do was pick up some of the NASA material that I would bring home and give to her and instantly the class would quiet down. The interest of kids is so great in what's going on in the space program it was just a natural. I think there's an opportunity to capitalize on that interest, and since that's where our future scientists and engineers are coming from, that enthusiasm is really pleasant to see and partake of.

I think this high technology and education conference is very good, and we're very pleased to host it. You will have some very

interesting speakers and then get a chance to take a look at the Lewis Research Center. Many people who have lived in this area all their life are surprised at our size. From Brookpark Road you can see one or two buildings. Actually, though, we're on about 350 acres and have about 500 individual research cells including large wind tunnels and test laboratories, and we have about 3,600 people come through the gate and work here every day. We're involved in aeropropulsion, communications, energy, and many other different types of research and technology, as well as the development of space flight hardware here at the Center. So I'm very glad that you chose to come here for your meeting today.

I would like now to introduce our next speaker. A fellow long-term NASA employee, Mr. von Puttkamer, holds a Bachelor of Science degree in general and mechanical engineering and a Master of Science degree in aerospace engineering, both earned in Germany. In 1961 he emigrated from that country to join Dr. Wernher von Braun and his rocket-development team at NASA's Huntsville, Alabama facilities, and that had to be an inspiration. I met von Braun several times; a truly visionary person, I think. When you think of space and the visions of the future, remember that Wernher von Braun was one of those who made his mark in history for being able to look far into the future.

In the following years at the Marshall Space Flight Center, Mr. von Puttkamer was very involved in the Saturn Apollo lunar landing program and Skylab space station program and the early development efforts in the new space shuttle. He received special NASA awards for his contribution to the Saturn V launch vehicle. In 1973 he was awarded a special director's commendation for his role in the salvage operations in the Skylab I mission. Inside NASA that was called the Chicken Little story. Skylab was a very large piece of hardware returning from orbit, and in a panic we were trying to figure out where it was going to come down. A very slight change in orientation or in the drag would move its impact point, the "footprint", a thousand miles one way or the other. Fortunately, it came down into the ocean and didn't bother anybody. I think all of us close to it were praying that it didn't hit New York City.

In 1976 Jesco was presented the NASA exceptional performance award for developing course rationale and detailed logic of the NASA future space program. In 1978 he received the NASA Cooperative External Achievement Award for developing new initiatives and concepts of participation with external agencies and in the public and U.S. space program planning and development activities. He is a member of AIAA and has authored numerous papers on a wide range of subjects such as the Apollo program, management systems integration, solar physics, space science, NASA future space programs, and space program benefits.

It's quite impressive to see the broad range of things he has written on. He is the author of the section on manned space flight in the new edition of McGraw-Hill Encyclopedia of Science and Technology and he has conducted a regular science column in the Future Life magazine. He has authored a chapter on the humanization beyond earth, the new age of space industrialization in the book Life in the Universe: the Ultimate Limits to Growth. On network television he has served as commentator of space missions, and he worked as a science advisor with Paramount Pictures on "Star Trek: the Motion Picture". I think all of us who work at NASA are Trekkies, and our ultimate goal in life is to be on the flight deck of the starship Enterprise. Mr. von Puttkamer has written a number of books on space flight and related themes. He is a prolific author and an internationally recognized spokesman for NASA and the NASA space program. You're very fortunate this morning to hear Jesco come and talk with you.

JESCO VON PUTTKAMER

Thank you very much, Andy. There was a time when a NASA Center Director never would have let on that he was a Trekkie! It shows how times have changed.

One of the NASA awards which Dr. Stofan mentioned, for Co-operative External Achievement, I earned by not being afraid of meeting with high school teachers a lot. Like today.

However, the task I'm facing is really quite ambitious: How do you talk about the long-range future in 45 minutes, without being unduly hardware-centered about it? I think the problem is that I'll be showing you some of the technology projects we are considering (since this is a high-technology conference) but I don't want you to leave with the impression that NASA is again talking about just big pieces of aluminum in the sky. I believe that if our future -- especially the space program and its development of high technology -- is to make sense and really is to be part of cultural development, we only stand a chance if we worry about more things than aluminum in the skies. The farther you look into the future and the more you are concerned about these projects I'm talking about, the more you realize that it's really not the engineering questions which we have to solve -- such as how much mass to put into orbit and how to settle the moon and how to fly to Mars. Much more important and also much more difficult is the question of whether we are able and willing and ready internally to talk about these developments in a more mature way than we used to do. Let me try to explain what I mean by this.

Dr. Stofan mentioned the exciting days with Wernher von Braun in Huntsville. Yes, working under him was tremendously inspiring, and in a way his spirit is still with us a lot. Wernher had a tremendous combination of child-like curiosity and wonderment about the future; and at the same time he had a very pragmatic and mature appreciation of the realities around him and the problems we might get into if we move ahead into the future too blindly, with tunnel vision -- you know: climbing the mountain just because it is there.

That kind of attitude was prevalent and apropos in the early Sixties when we flew to the moon. Today, when we talk about the long-range future, I think the maturity in the country at large has grown, people have become much more skeptical about science, about government, about politics, about other countries, about everything. They have become more aware than ever that they are just part of mankind rather than all of the world. There was a time when many people here considered the U.S. the world. Today, the awareness is widespread that we are just a tiny minority in this huge population that is getting closer to five billion every day. There is the growing realization that 80 percent of mankind, in particular, are living in underdeveloped and developing countries. Four-fifths of mankind are so far removed from our standard of living, quality of life, life expectancy and everything else that it would be totally amoral, even idiotic, to talk about the world of a future 40, 30 or 20 years from now without consideration of all those other people.

And so in our long-range planning at NASA we are driven from the preoccupation with technology to the question of "What about people?" This may sound like a simple question but it's quite involved -- and not all of it, as you look farther into the future, is a purely rational process since on the highest level of planning it involves not societal functions and political objectives but global human values (Figure 1).

I'd like to show you some of the logic behind the future projects and attempt to share with you the evolutionary-type feeling

NASA's MISSION:
DEVELOPMENT OF MAN—EARTH—SPACE: ONE CREATIVE SYSTEM

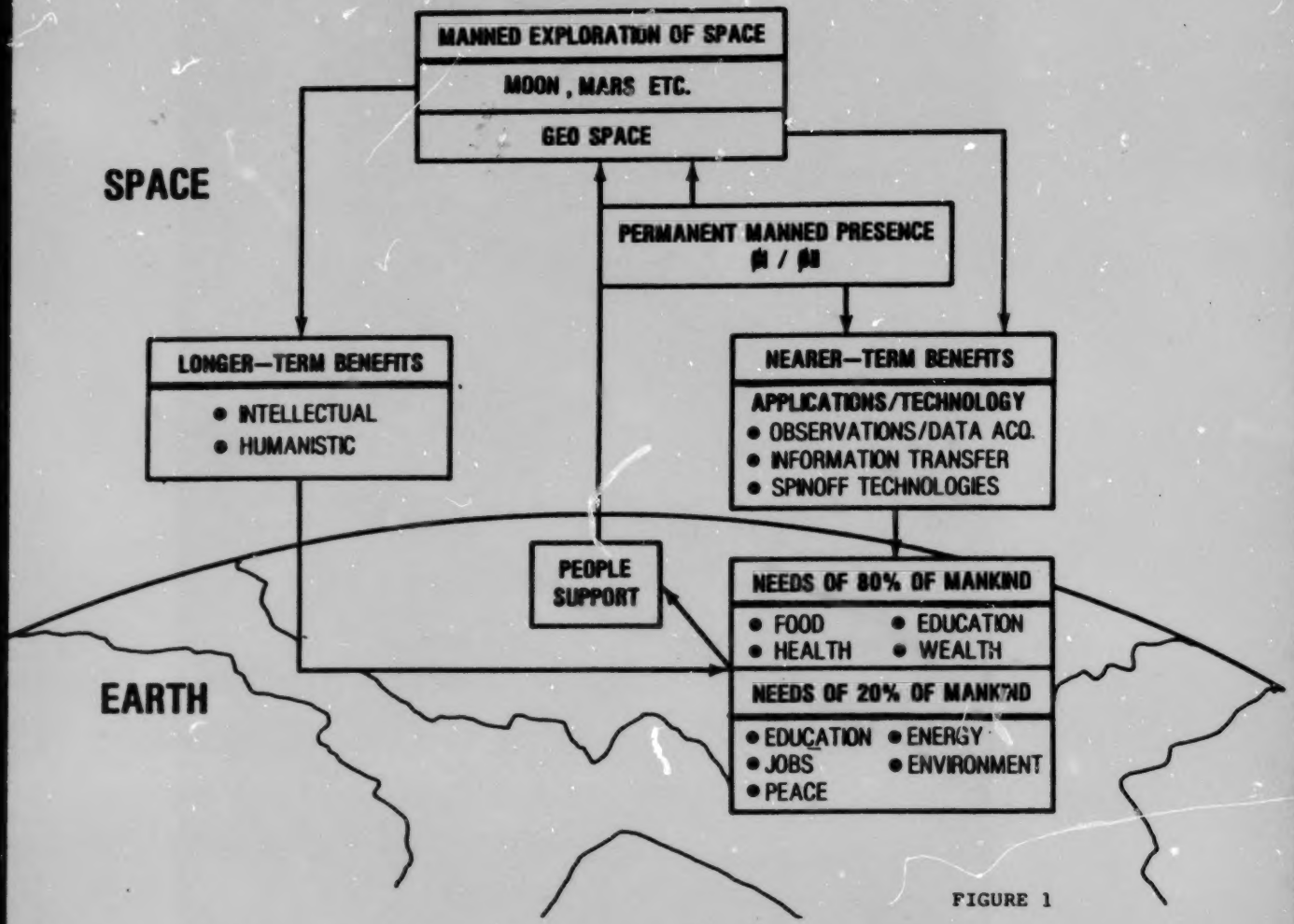

FIGURE 1

one gets from looking at these technological developments from a long-range perspective. But I want you to come away with the understanding that this is not the way the future will be. This is the way the future could be if we are willing to make it that way. Most of the things I'll talk about will never actually happen if we just sit back and wait for them to develop by themselves. We should realize this clearly, particularly you as educators, and when we see the wonders and the miracles and the possible solutions to future problems, we should ask ourselves, "Are we really preparing children for the Third Millenium?", because the kids of today and tomorrow will be the people who will control those exciting years, those generations beyond the year 2000. I firmly believe we are obliged to ask if we are really preparing them properly for that future, or if we are still giving them a mindset pertaining to the past?

Wernher von Braun used to tell us that a picture is worth a thousand words, so I'm going to put on some more slides and take you through them.

Let's start with the basics -- the Space Transportation System (STS), as we call it (Figure 2). I'm sure the Space Shuttle is familiar to all of you thanks to the local and national media. But we have not just the Space Shuttle but a transportation system consisting of an entire family of elements in an infrastructure by itself, manufactured at various contractor plants. Its focal point, the firsworks technology, of course, is the Orbiter; that's what we see all the time. But no less important are those elements like the External Tank for propellant storage; the strap-on Boosters which help us to get out of the heavy part of Earth's gravitation until the somewhat less powerful engines of the Orbiter can carry on into space; the Spacelab, which is an international contribution by the Europeans that has already flown on a mission of great success; and a bunch of upper rocket stages which allow us to reach higher altitudes than the Shuttle itself -- since it wouldn't make much sense for it to carry all those lifting surfaces

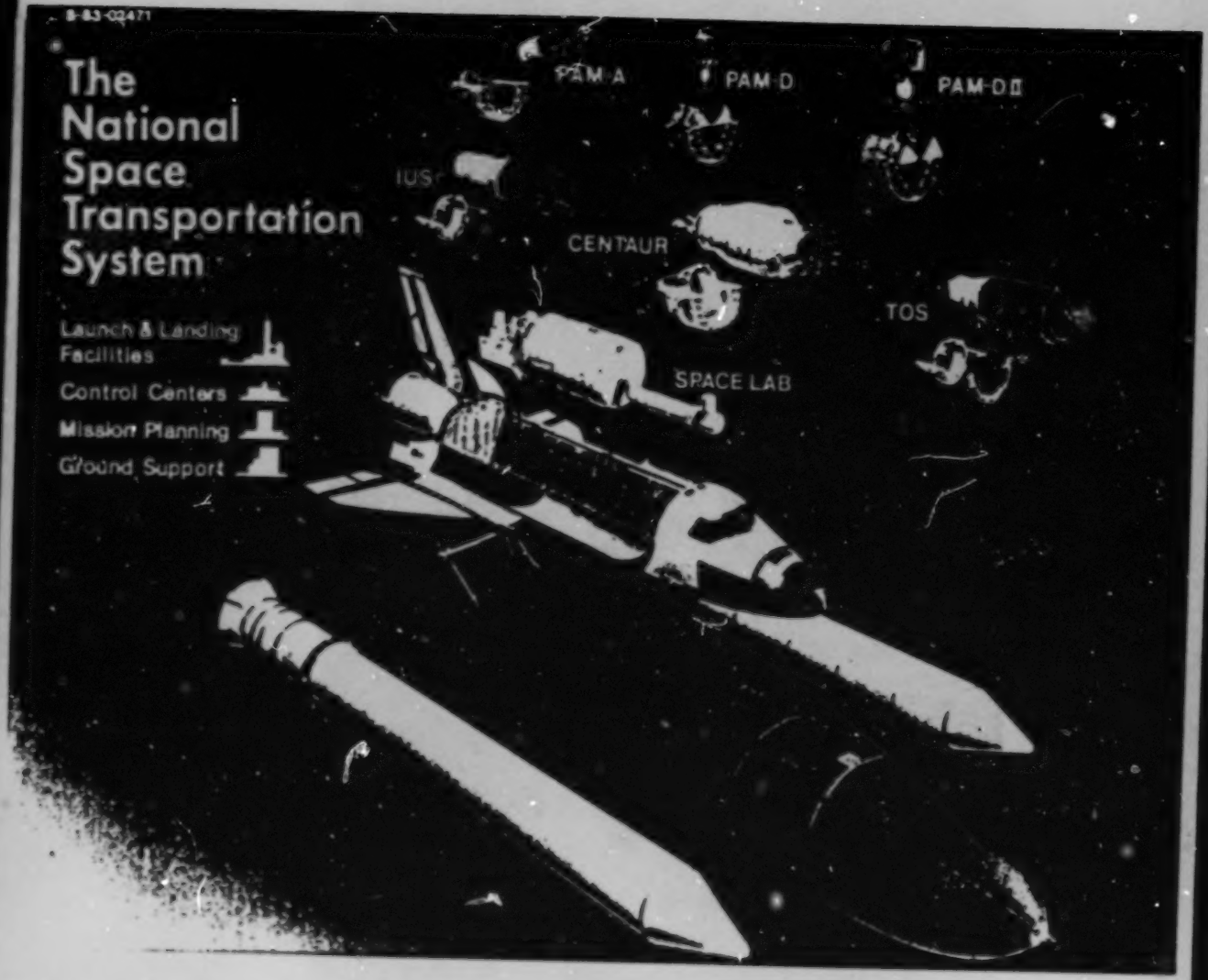

FIGURE 2

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like the wings and the vertical tail to altitudes beyond the atmosphere. Instead, we take regular rocket stages and launch them from the Shuttle just like we launch rockets from the Kennedy Space Center.

Thus, the Shuttle is already pioneering many of the activities which the Space Station will be doing operationally, representing a little Cape Canaveral in orbit with all the check-out, countdown and launching functions which that entails. Eventually we are also going to put functions of the Lewis Research Center and other NASA Centers into orbit by building an R&D laboratory in space, where a lot of the things which our research institutions are doing here on Earth can be done better. Simulating space on Earth in the development of new technologies often is rather severely limited, and only by putting R&D actually into space can you get around that barrier of gravity.

Getting back to the STS infrastructure, the next picture (Figure 3) is an actual on-board photo of the first Spacelab flight, showing a group of scientists at work in the weightlessness. There were six crew members though you see a smaller group here. For example, there is Owen Garriott, formerly a Skylab astronaut, who is one of the most experienced mission specialists we have. The guy on the right is a German astronaut, Dr. Ulf Merbold, who flew along and was the first of many international guest crews to come on future Shuttle flights. The group conducted many scientific experiments which by now have been judged as highly successful. For the scientists among you, Science magazine put out a special issue in July with early preliminary results of most of the experiments of the first Spacelab mission.

I could talk two hours about Spacelab alone, but let it suffice at that -- except for a few words about the phenomenon called space sickness. It's kind of funny, don't you think, that even in weightlessness the astronauts are still oriented vertically up and down. Their heads are up and their feet are down, but they really don't have to be that way. There are basically two reasons for this. One, it's simpler for the ground engineers to design a Spacelab the "right way", namely

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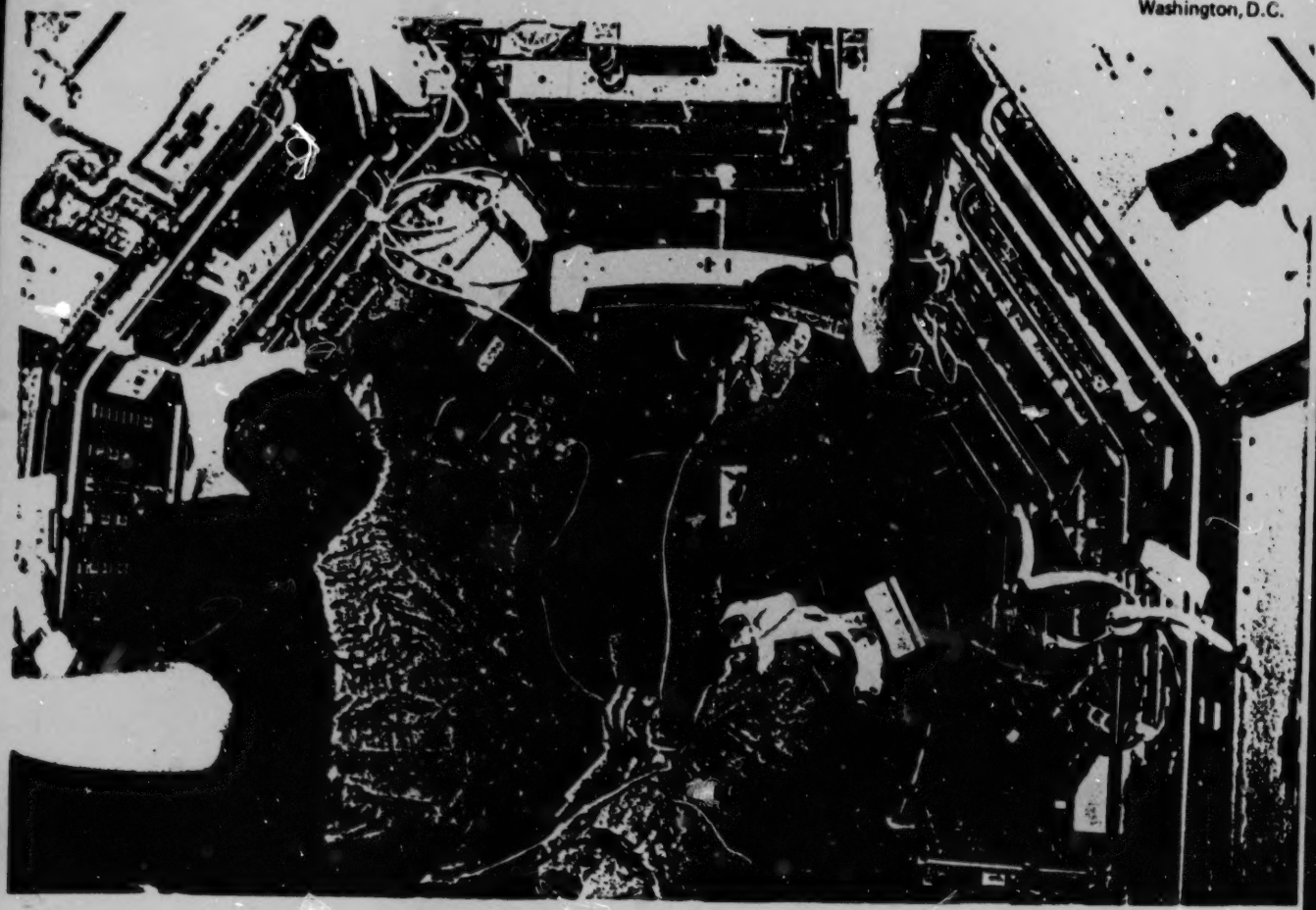

FIGURE 3

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the ceiling being up and the floor being down, because they have to walk into it on Earth, installing the equipment. Since you need it during the development and countdown periods anyway, you might as well have a floor. The other reason is psychological. It's been found that visual cues can upset the stomach; that means if an astronaut is floating in an unusual attitude, for example with the feet pointed to the ceiling, the person looking at him unprepared for the sight could get an adverse reaction. It's a very strange thing, this phenomenon, and NASA is putting considerable emphasis on investigating this Space Adaption Syndrome, as we call it. It's an expression that we prefer to "space sickness". The latter is an imprecise term because it gives the image of sea sickness -- where you are really sick to the point that sometimes you want to die. (I'm a scuba diver, and I know!). Space sickness is not really a sickness but a kind of disorientation with some nausea, accompanied sometimes by stomach upset which we don't quite understand yet. It may have to do with primordial instincts of preparing the body for flight and throwing off your hungry pursuer -- which was probably apropos in the days of the cavemen when you had to run away from a bear. In our space age, especially in the Space Station, it's kind of a funny anachronism to have a cave age reaction in a space age situation. It'll be just a matter of time until NASA solves this problem, I'm sure.

Another thing that I wanted to highlight is the fact that humans here have found a new freedom -- to a much larger extent than the picture shows. They have found freedom even from the Space Shuttle itself by being totally untethered, unbound, floating freely in space. This is shown on the next picture (Figure 4) which depicts Astronaut Bruce McCandless on one of the recent flights, drifting at least 300 feet away from the Orbiter.

Later he reported a bit on the psychological switches of floating free and seeing Earth spinning far below. When he looked at the Shuttle, he felt himself totally stationary in space because the Orbiter remained at a fixed distance without moving away. But when he looked down and saw Earth moving, then all at once he was aware of speeding along in

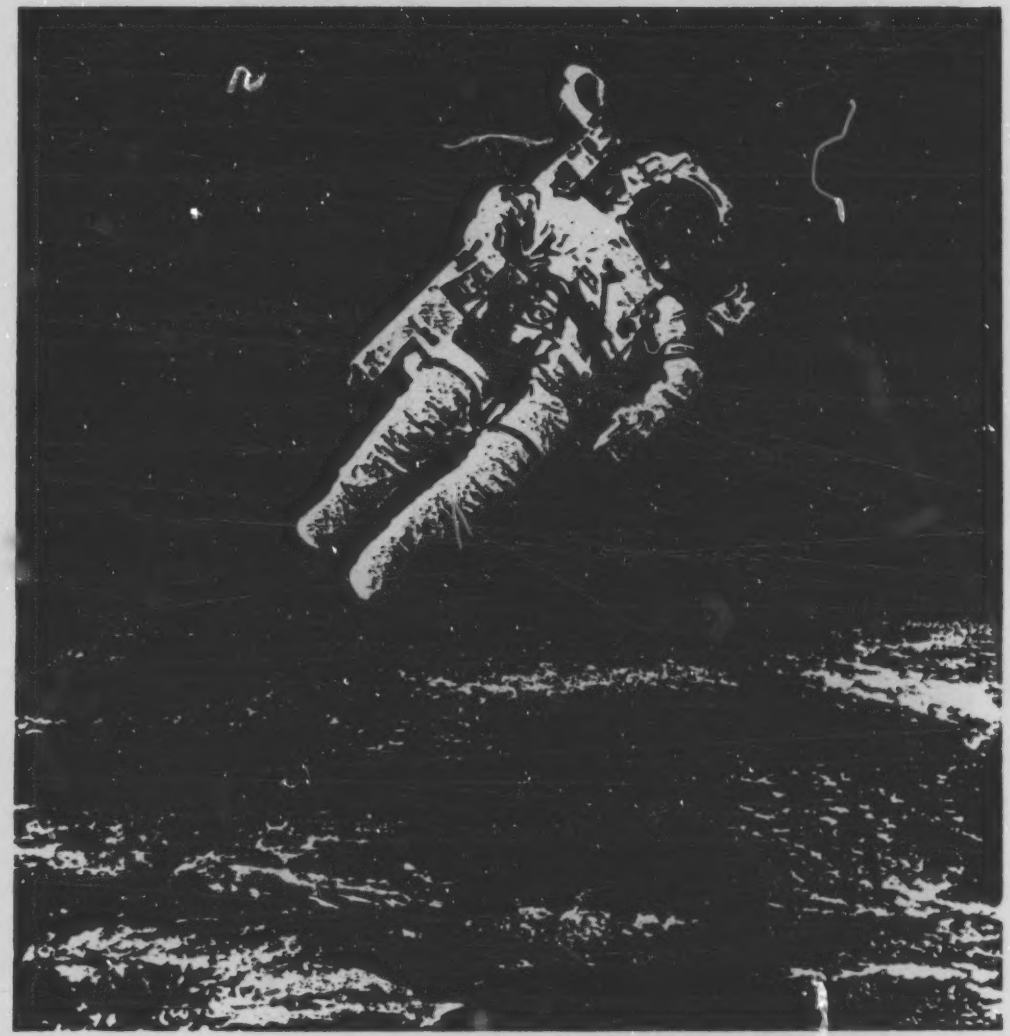

FIGURE 4

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space at 25,000 miles an hour. Thus, depending on where you look for your frame of reference, your appreciation of yourself changes a lot -- which is somewhat apropos to all of us, I guess. It makes us much more aware that we are a process rather than just a point in time, and that things are in flux and flow all the time.

The question thus is, are people in the future going to be psychologically affected by the space experience? Are they going to feel freer, are the kids growing up seeing more and more such pictures going to feel less bound to Earth? In other words, are they going to change basically in the long run by having found this freedom from gravity in the psychological sense? That question is unanswered, and it will remain unanswered for a long time.

As far as the next few years are concerned, the following chart (Figure 5) shows what we are planning for the National Space Transportation System in terms of number of flights per year. Thus, in 1985, the Shuttle will fly once a month. You are going to see Shuttle missions quite regularly, and they'll fast become routine, just like an airplane taking off. In a little while, your children will look at you and say about that, "So what? When are we going to fly into space at last?" You'll tell them, "Hey -- aren't we flying into space all the time?" And they'll say, "No, that's not space! That's just the front yard. Space is when Earth is as small as a Ping-Pong ball." Because they hadn't been born when we walked on the moon. For them, men walking on the moon is history, just like Napoleon and Columbus are history to us -- sometimes boring. They have a totally different view of space, and it's going to be even more different in the future.

Right now NASA has three Shuttles to handle the job -- the Columbia, the Challenger and the Discovery -- and there will be a fourth Shuttle called the Atlantis in 1985. These are all names of famous old ships; of course, there is the pioneering Orbiter called Enterprise, named after the Enterprise of Star Trek. It's back at the plant and won't ever fly into space.

PLANNED

NASA NSTS SHUTTLE FLIGHT RATE

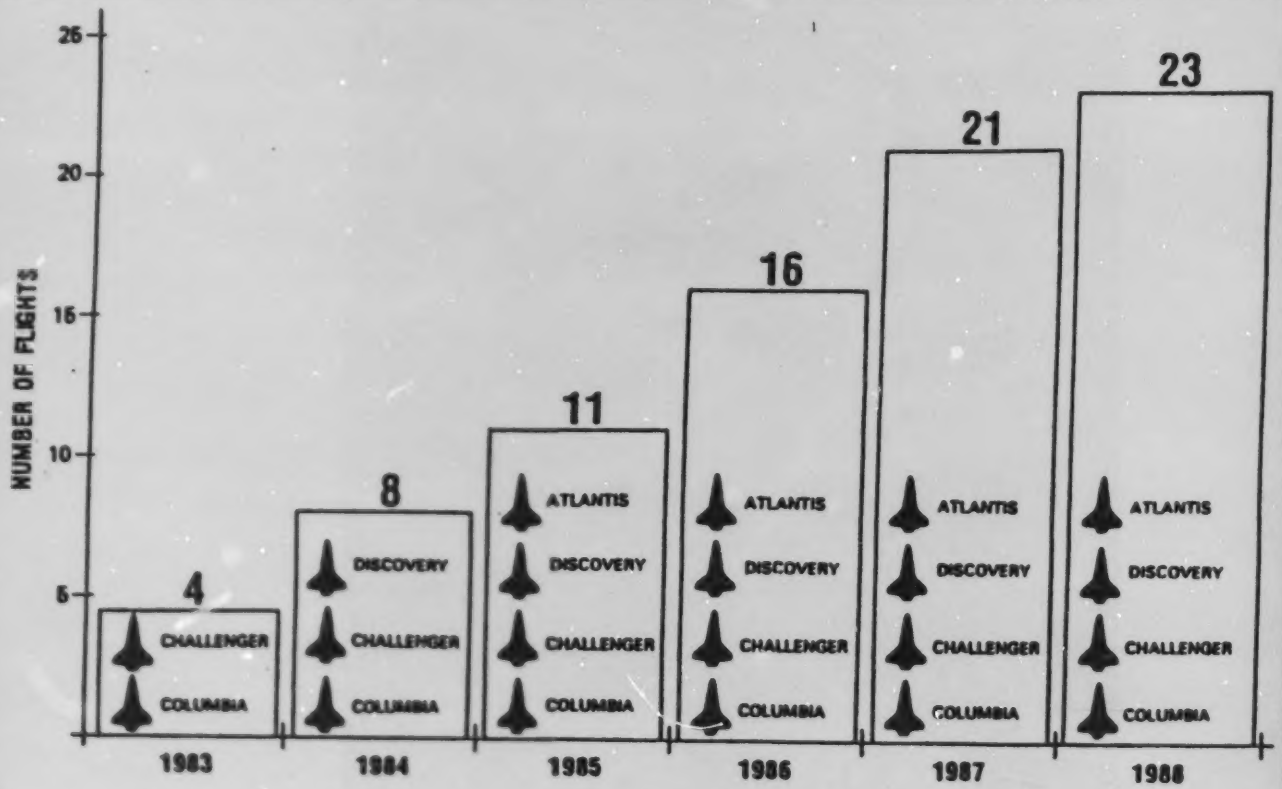

FIGURE 5

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Our strategy for space in the future is a logical continuation of where we are and have been (Figure 6). We went through the pioneering days with Mercury and Gemini, the exploration years of Apollo -- very exciting and ground-breaking, but also controversial to a lot of people during the late Sixties as far as how they related to perceived social needs, internal domestic upheavals and our Vietnam involvement. Mind you, Apollo wasn't designed to handle those problems. It was designed in 1961 as a kind of national psychotherapy to counter our own doubts in face of the perceived Soviet threats; and to put this country back on a track of feeling proud and showing the world that technology and science developed by a free country were still leading. But when we landed on the moon in 1969, we seemed somewhat out of synchronization with the outside world. It had changed so much that people looked at us and said: What business do you have landing on the moon when our inner cities are burning, when our leaders have been assassinated, and so forth? And the reason is simply that in 1969 we were doing our 1961 "thing", relating to other priorities of another age and of another President. Thus, Apollo was terminated after only six landings. We planners had envisioned a continuation of the program, called the Apollo Extension Systems, with a small base on the moon eventually and then manned flights to Mars. All that was cut off because we couldn't address the more immediate priorities of the time.

As we now come to the Space Shuttle, which is much more flexible, and the Space Station, the Space Program will be considerably better equipped to respond to a rapidly changing outside world. But while Apollo may have been too monolithic, too rigid for our dynamic environment, and while we may have been living in a Shangrila of engineering in those years, I know that there were many people like me in the Space Program who had a strong intuitive feeling that what we were doing was right in the long run -- that while we couldn't expect to help the nearer-term problems, we were working toward some of the solutions of the cardinal problems of the future. But I think with the Shuttle, with the Space Station and with all that they entail, we can be much more relevant to the world -- if we want to.

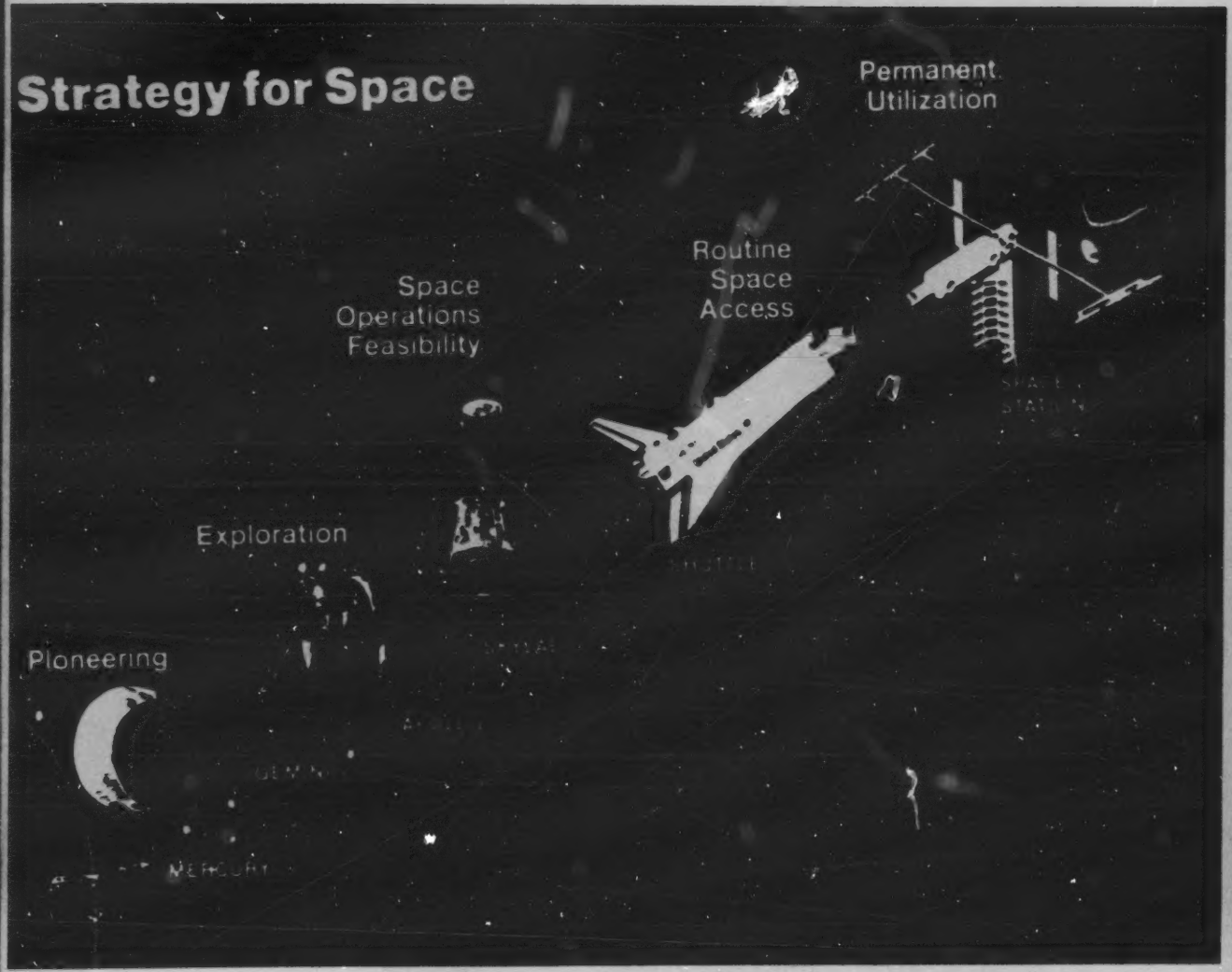

FIGURE 6

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I'm dividing our progress in space into a number of logical steps here on the next slide (Figure 7). The first phase I call achieving easy access into and out of space. This is what we are engaged in right now, and it'll continue until about 1990. As you look at the progress of technology, it doesn't develop exponentially or explosively. That's a myth. Technology doesn't accelerate continuously. Like human capability in general, it progresses more along an S-curve. There is always a slow beginning, followed by a rapid increase with a high leverage of technology, and then that technology leans over because you can't squeeze any more capability out of it beyond a point of diminishing returns. The technology is then replaced or substituted with a new one which undergoes its own S-shaped development. Thus, technology really progresses more like a staircase, with steps and intermediate landings, and you reach plateaus from which you can look back and forward before you start another assault and climb up another increase. The preceding plateaus do not vanish but remain in existence henceforth, just as the bacteria from which we have developed are still around us today. Progress, therefore, means not only increasing capability but necessarily also increasing numbers of interactions -- that is, complexity.

Achieving easy access into and out of space requires a whole infrastructure of elements, as the slide indicates. The next decade then would be dedicated to achieving permanent occupancy of near-Earth space by people. This again requires a number of subgoals and its own infrastructure. Beyond that lies the third phase, to achieve limited self-sufficiency in space in order to cut down on costs of re-supply and drainage of Earth's resources. The evolution of men and women in space (Figure 8) proceeds from the passenger and operator, observer and experimenter on Mercury and Gemini all the way up to explorer, repairman, scientist, serviceman, worker, builder, innovator, producer and finally (why not?) resident, family founder and parent.

Skylab was our first space station (Figure 9). It demonstrated the feasibility of manned existence and operation in space over an extended period of time. Dr. Andrew Stofan mentioned the sad demise of

MAN'S PROGRESS IN SPACE

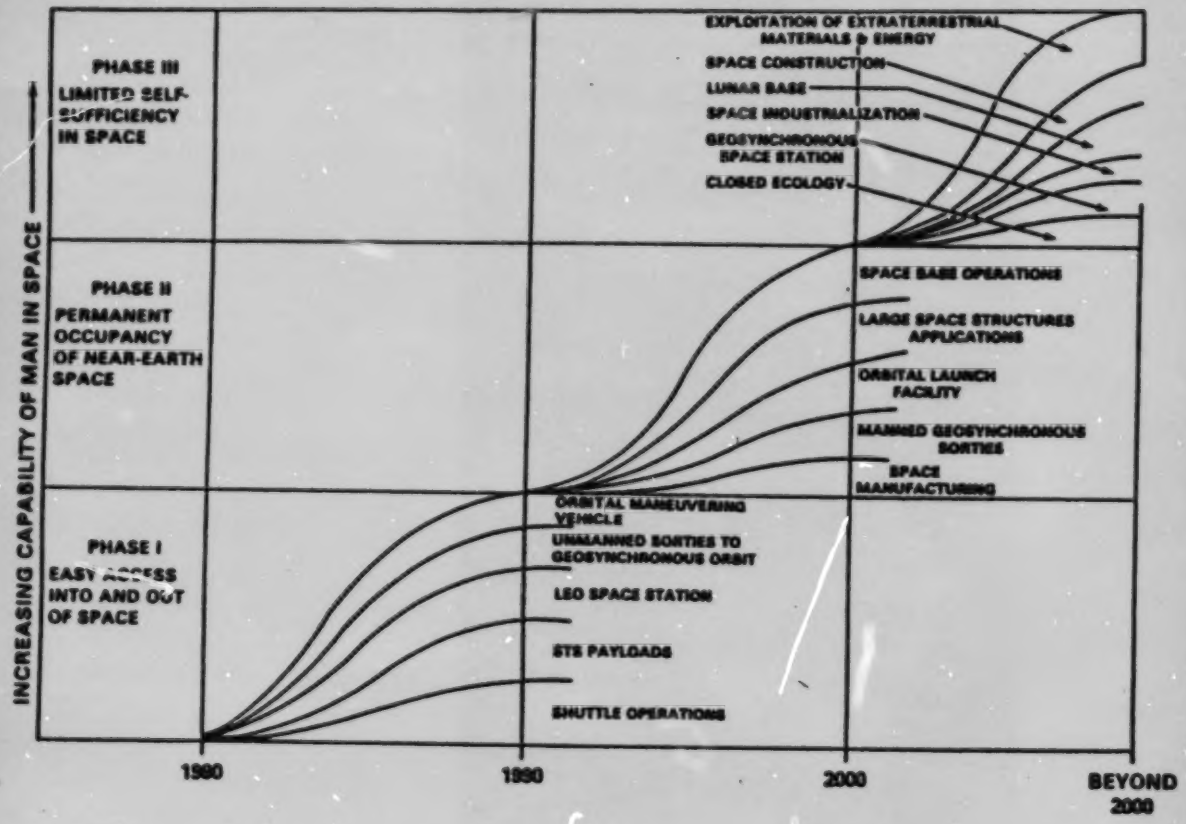

FIGURE 7

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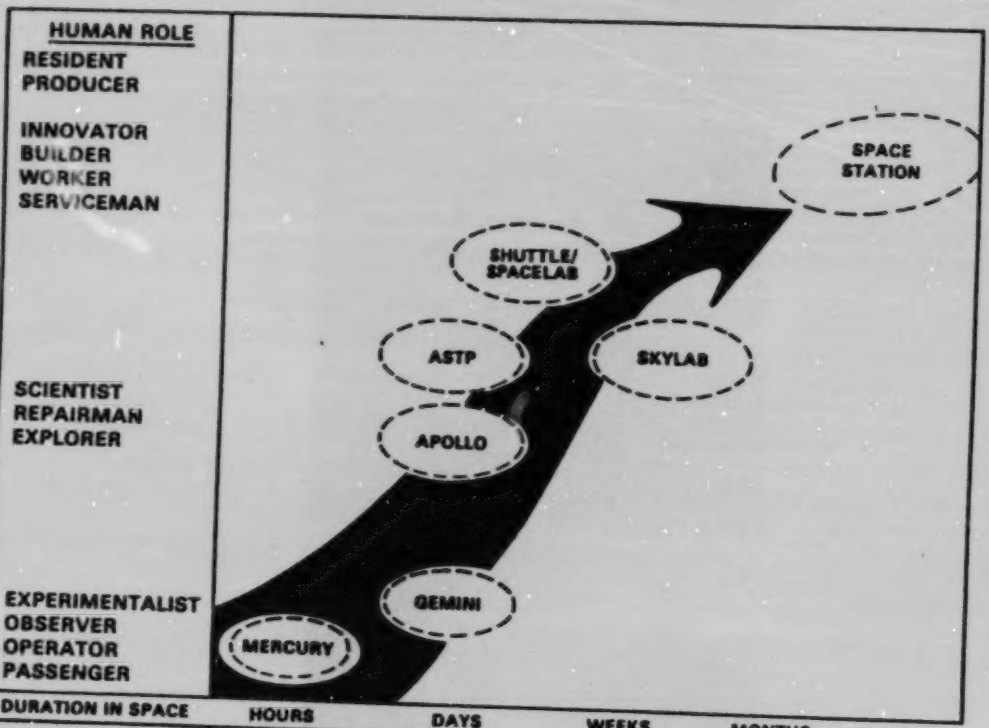
EVOLUTION OF MAN'S ROLE IN SPACE



DURATION IN SPACE	HOURS	DAYS		WEEKS	MONTHS	
	MERCURY	GEMINI	APOLLO	SKYLAB	ASTP	SPACE STATION
TOTAL MANHOURS	54	1940	7560	12,351	652	INDEFINITE
EVA MANHOURS		12	168	82		INDEFINITE

FIGURE 8

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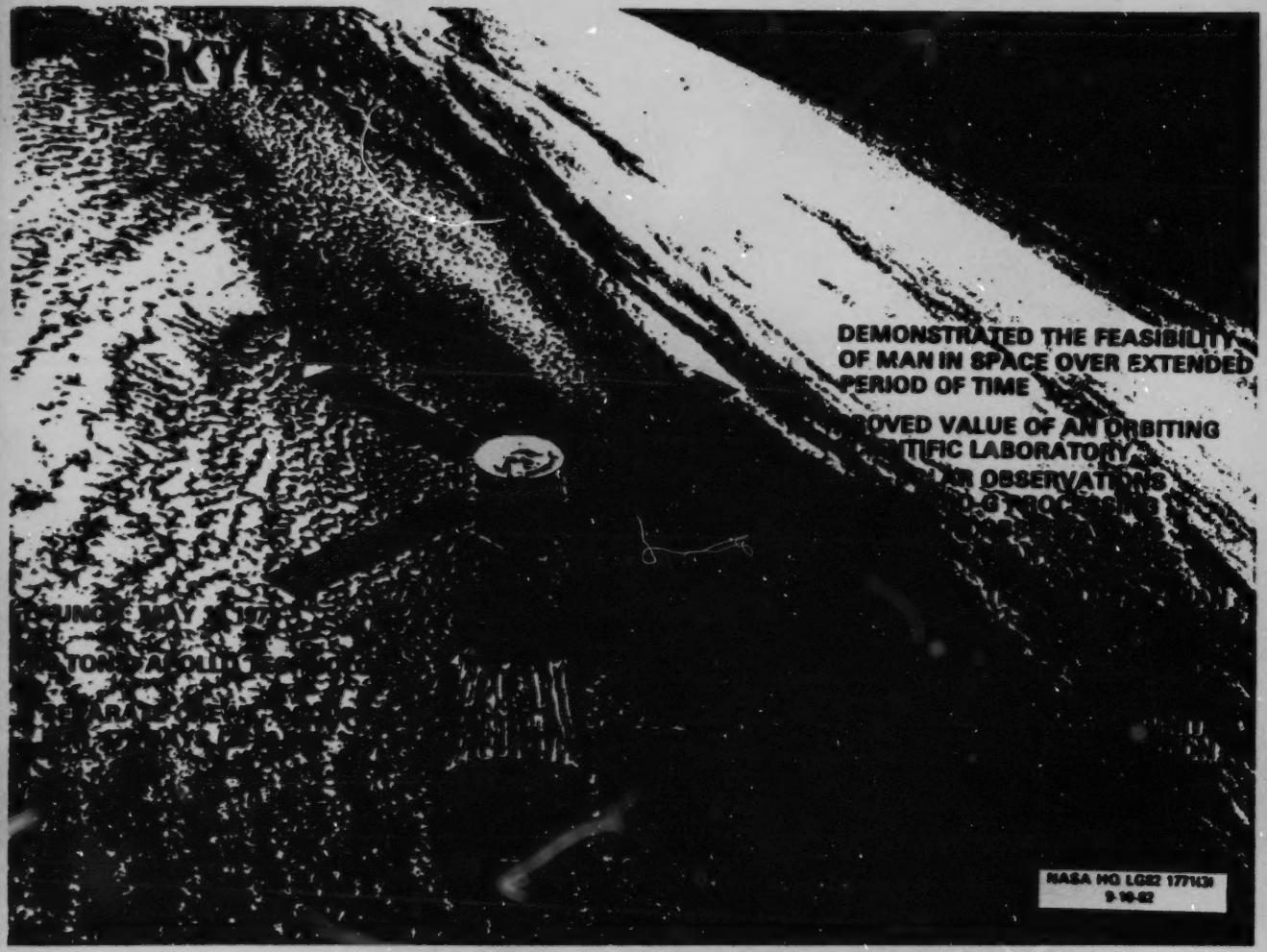

FIGURE 9

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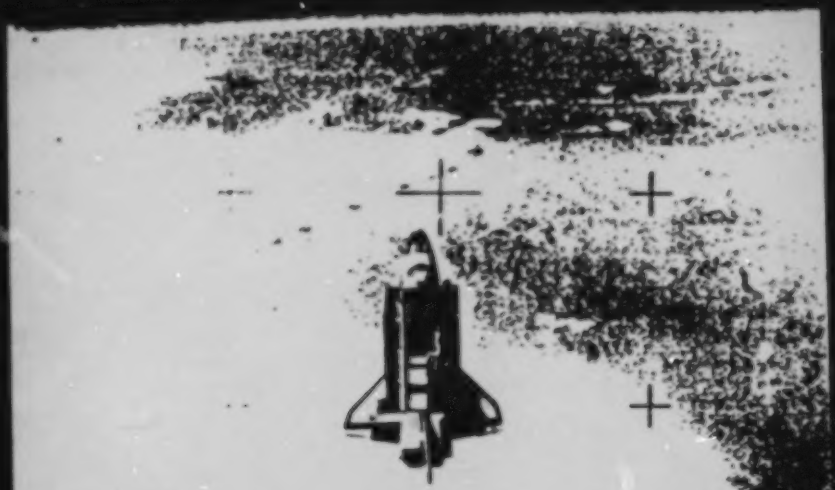
Skylab when it came down and almost fell on Australia. Our engineers were pretty ingenious in managing its last few hours by controlling its attitude and its air resistance, its atmospheric drag, but what I was much more involved in at the Marshall Space Flight Center was not the reentry but the launch of Skylab in 1973. We had an accident during launch, and by the time Skylab arrived in orbit it was so heavily damaged that there was talk about not wanting to put people on board. We went through ten days of very hectic engineering and rescue activities, to get the facility back into operating condition. You can see here the repairs that have been done: one of the solar array wings is missing, ripped off during launch, but the other was still there, enough to produce electricity for the crews. Also, we had to protect the workshop with a shadow shield from the sun because the thermal protection shield to do the job had also been lost during launch. The astronauts actually climbed around the outside of the Skylab and put up this sun shield.

Why are we now going for a Space Station? There are many reasons (Figure 10). The fact that the Shuttle is becoming operational and that development programs take a long time is one of them. We have to start now or we will be missing a chance. The Soviet threat to our leadership in space is very real. They do have a space station, currently with three cosmonauts on board. They went beyond a staytime of 211 days two weeks ago, the absolute record to date, and every additional day is a new record for them. Another reason is that the U.S. economy requires bold investment in new technology.

There are several Space Station concepts under study at this time. The one shown on the next slide we call the Power Tower (Figure 11). A space station is much more than just a place for people to live. You need to add functionality, for them to do things, like a research laboratory, assembly and construction of structures, cranes, checkout and maintenance bays, antennas, and so forth. And you have to add a power source -- electricity for the life support system, the furnaces, etc. But you want to avoid shadowing the Space Station and to stay out of the way of

- DEVELOPMENT PROGRAMS TAKE TIME
- SHUTTLE IS BECOMING OPERATIONAL
- SOVIET THREAT TO U S CIVIL LEADERSHIP IN SPACE IS REAL
- U S ECONOMY REQUIRES INVESTMENT IN NEW TECHNOLOGY



SPACE STATION: WHY NOW?

FIGURE 10

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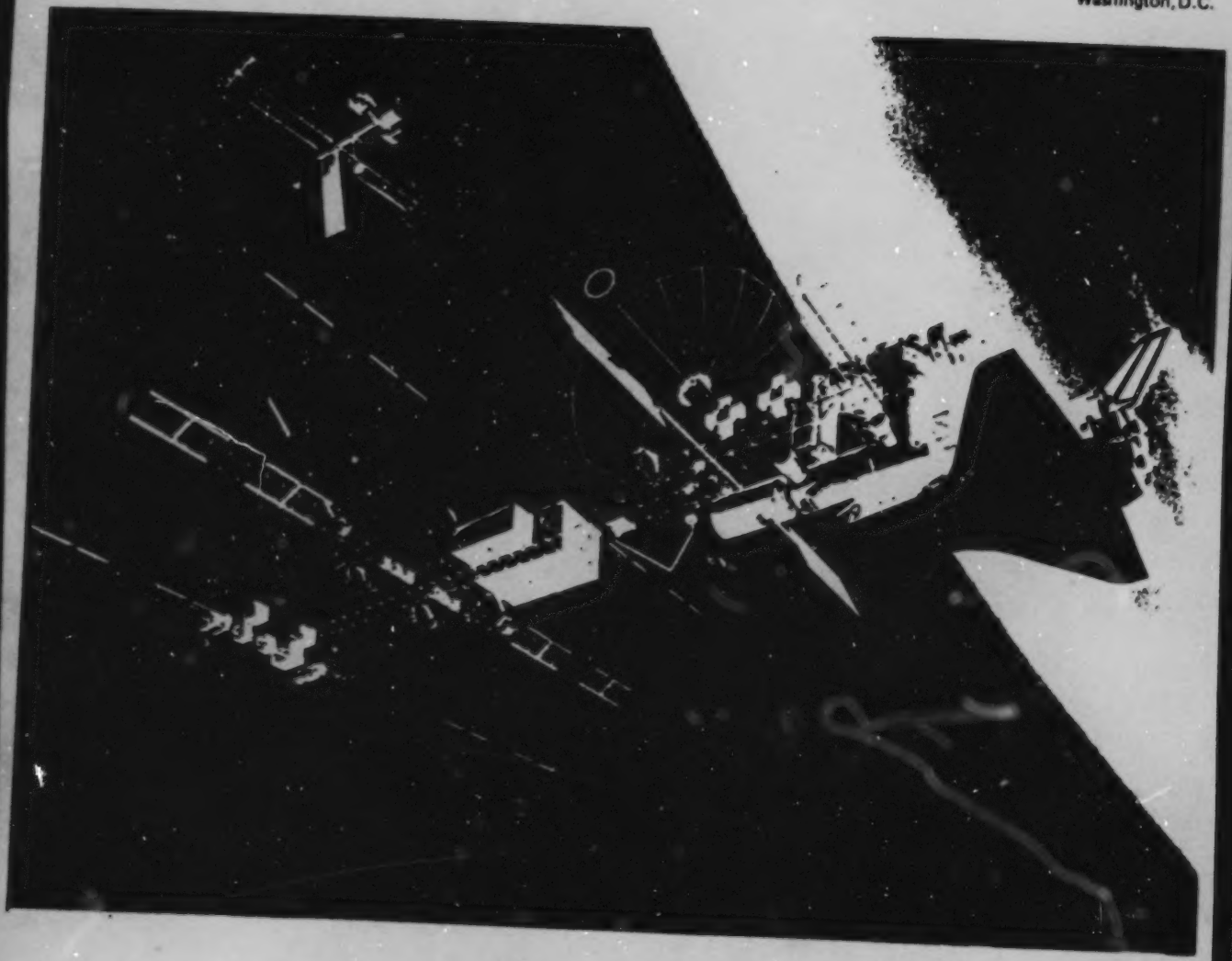

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FIGURE 11

approaching Shuttles; thus, the solar photovaltaic arrays are sitting on outriggers that are very long, thing, flimsy structures -- the Power Tower. It's over 300 feet long and 200 feet wide, shaped like a huge cross in space. The Lewis Research Center here has been given responsibility for all the power subsystems on the Space Station -- and that is a tall order indeed, as you can see. We need about 75 kilowatts to start with, with growth capability well beyond that level.

Thus, as requirements dictate, the Space Station will grow to larger size. Its internal arrangements, today, are far from being defined. You could design your add-on module with a gravity-type orientation where the floor is "down" and the ceiling is "up" like Spacelab, for the reasons I mentioned before, even if that isn't efficient in space where weightlessness would allow you to use the entire inside circumference of the module.

I think, when people will really have adapted to space and gotten away from that psychological hang-up with gravity, architects and interior designers will be able to design better interiors. They'll be asking a lot of psychological-type questions which we haven't dared touch yet. Right now and for quite a while, NASA will not be able to provide interior designs for the Space Station such that people will feel really at home there. Home is when you don't want to come back down, so to speak. For reasons of costs and engineering constraints such as mass, dimensions, volume, etc., Space Station interiors will be pretty functional and frugal. Life on board will be similar to a military duty cycle, and the guys and gals on board will want to come back after a little while because it'll probably get monotonous and boring after a while -- as the Soviets have already discovered. But for achieving genuine permanent presence in space, without too frequent crew rotation, you can't afford to continue that way.

So I foresee a program of increasing evolution of liveability, of habitability, of productivity in space. A new culture has to develop there, even in that peculiar area of interior architecture, just like

ocean steamers have developed their own style: those old Queen-Mary-type ships with the sweeping stairways and with lots of plush, brass and teakwood paneling. That was a cultural, very human development spun off by a functional technology, namely ships. Or take the oldtimers out of Detroit such as the Ford Model T. Those old cars today are classic, they are beautiful and aesthetic. You wouldn't consider them machines anymore; they have developed their own cultural identity. In a similar way, I think, space structures also will develop their own architecture if given half a chance. We can't second-guess them right now but we know that we shouldn't just replicate a submarine out there. We may be able to build flexibility in even at an early stage and -- to a certain degree -- allow our crews to modify their environment in accordance with their own individual preferences. The question is, how can we get this connection to the cultural mainstream, this fertile ground for a future cultural evolution in as early as possible? We want to avoid the strait jacket of technological functionalism which would kill cultural evolution and just continue a technological side-line like living in a submarine? This is one of the problems that we are going to be facing when we talk about permanent presence in space.

The Space Station, like the Space Shuttle, again, does not exist in a void, but has an entire infrastructure of things around it, other elements which really enable it to work (Figure 12). Besides the Shuttle there will be the OMV, the Orbital Maneuvering Vehicle -- a remotely controlled little spacecraft with television, allowing us to relate between the Space Station and platforms and satellites. How do you get a satellite back to the Space Station for repair unless you have a long enough reach? So an OMV is just like growing a very long arm and extended vision with a television camera. Also, we need upper stages like the OTV, the reusable Orbital Transfer Vehicle, for launches to higher orbits and more distant goals, as well as free-flyers and platform-type carriers which need to be away from the Space Station for reasons of contamination and vibration. The geosynchronous orbit (GEO) out at 22,000 miles is a unique location because everything there appears to be stationary over

ELEMENTS OF SPACE INFRASTRUCTURE

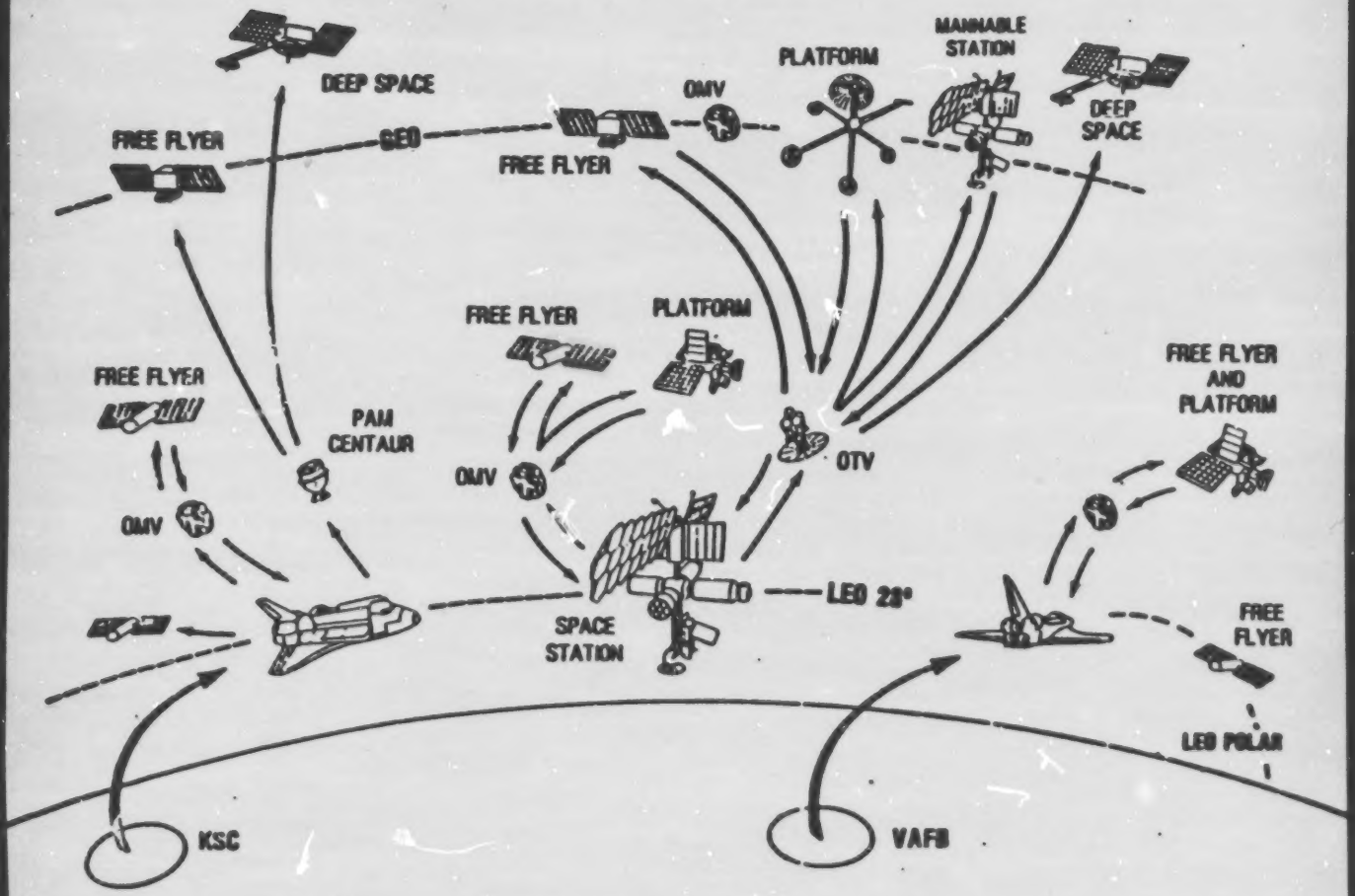

FIGURE 12

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the Earth as it turns around it at the same speed the Earth is turning. We need to be able to reach that altitude with our communications satellites, and they will be getting larger and more complex in future years.

The real estate in geostationary orbit is extremely precious because it is limited -- as paradoxical as that may sound in endless space. As more and more users vie for positions for their communications systems, there will be an increasing problem of traffic congestion. One possible solution is shown on the next slide (Figure 13). To economize, you'll want to get away from individual satellites and combine the functions of many satellites on one platform with common housekeeping. This requires a number of antennas, and so the structures will clearly grow in size in response both to increase in demand and the congestion problem. They'll also become more complex and more expensive, and so they will need to stay in business for a longer duration in order to work off their costs. That means they will have to be repairable and serviceable.

But how do you get away from Earth out to 22,000 miles to repair a satellite platform? First you do it by remote control, with manipulators controlled by someone sitting in the Space Station or on Earth in front of television screens. Later, you'll have people flying out, actual repairmen on sortie flights, fixing satellites and complex platforms out there and then flying back down. All of these are very clear, practical needs which we can already perceive today that tell us that we will eventually have to fly people at least out to geosynchronous orbit and back by, say, the year 2000.

Beyond that time, when the Space Station has successfully established a permanent foothold for us with research, manufacturing of pharmaceuticals and other commercial materials, and all the other early capabilities that are part of the Phase I Space Station -- the one which President Reagan has mandated NASA to develop -- there will be further growth to include the assembly and construction of large structures and the launching of large reusable rocket stages, the OTV, to high orbits, to the moon, and to the planets. This evolution takes

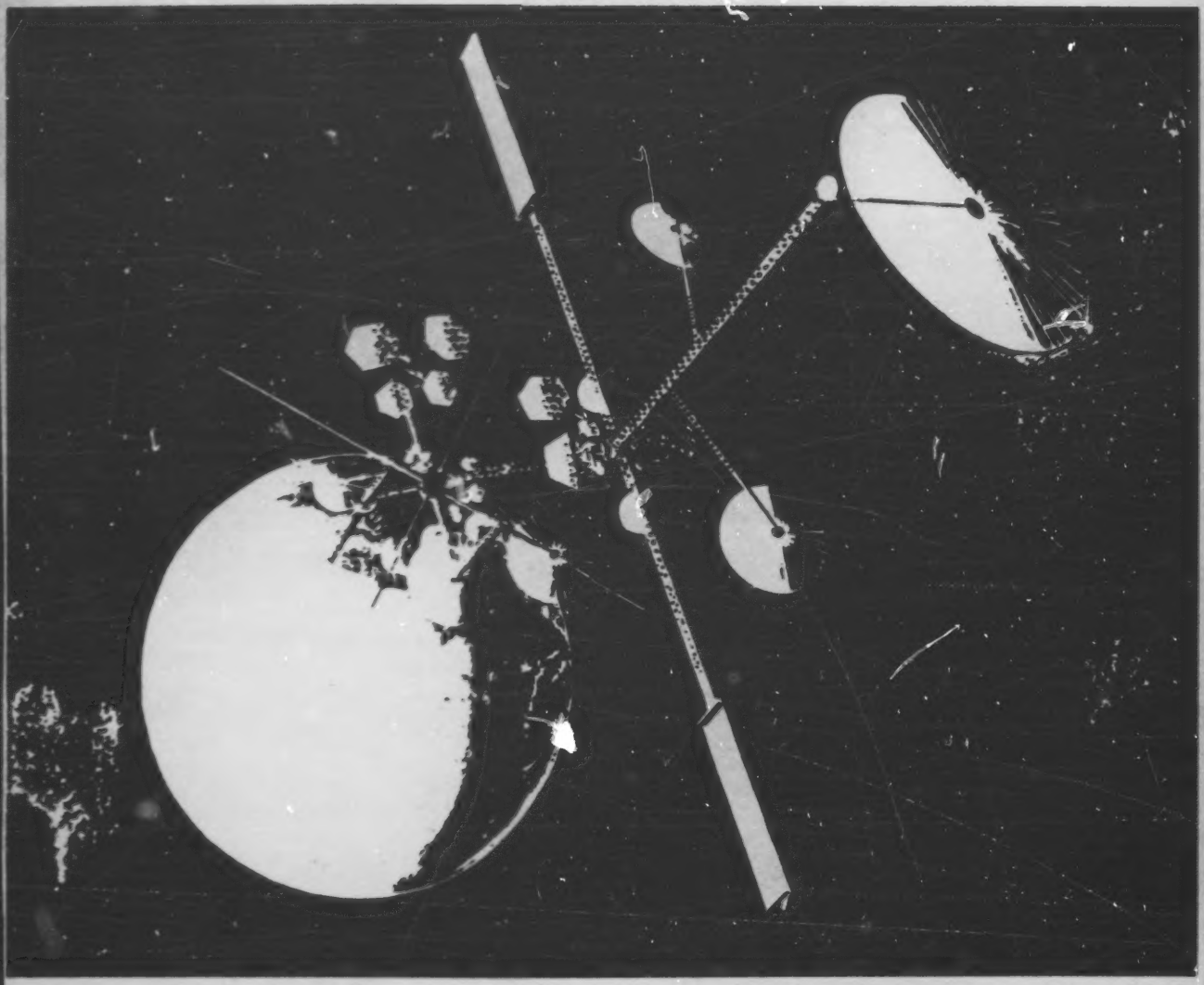

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FIGURE 13

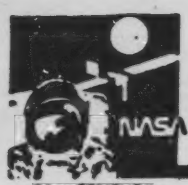
us to a second phase of the Space Station which will really turn it into a springboard, a gateway, a beachhead to longer-range missions in the future.

Long-range projects cannot simply be conceptualized without some a priori understanding of what they are for. Thus, I need to study goals and benefits first, before I develop the requirements which their attainment calls for. An analysis of missions and goals is shown on the next slide (Figure 14). Here, a number of goals are defined which appear to be valid today, in 1984. For example, science and exploration, commercialization, application and expanding presence, and each of these has certain benefits to mankind of various kinds. Notice that many of them are the kinds of benefits that have little to do with turning a direct dollar profit.

Sure, there was a time when making a buck was the number one motive, when your success in life was judged by how much money you made. Generally speaking for the U.S., that's still the case. If this attitude prevails and continues to define Western society, we are not going to do a lot of the things I'm talking about here, because as you go away from Earth beyond geosynchronous orbit, the materialistic, commercial, free-enterprise type of motivation can justify less and less of it. Transportation and sustenance are getting too expensive. To make you go out there, other reasons, other motivations, other priorities will have to move into the foreground. Since we generally don't subscribe yet to the mental attitude that sees greater value in humanistic and intellectual benefits, in my opinion we are just not going to do it until people have changed.

Therefore, to talk about returning to the moon and going on to Mars will remain just talk unless something is happening in our minds here on Earth first -- and this is where education comes in.

The chart shows three kinds of benefits. The intellectual ones (indicated by I) have to do with knowledge -- where do we come from,



POST-SPACE STATION MISSION GOALS

GOALS	BENEFITS	TYPE *	DOMAIN INVOLVED
SCIENCE AND EXPLORATION	DETERMINE ORIGIN & EARLY HISTORY OF SOLAR SYSTEM	I	LEO & OTHER SOLAR SYSTEM SCIENCE
	UNDERSTAND GALACTIC STRUCTURE & DYNAMICS	I	LEO & OTHER SOLAR SYSTEM SCIENCE
	UNDERSTAND COSMOLOGY	I	LEO & OTHER SOLAR SYSTEM SCIENCE
	VERIFICATION OF PHYSICAL LAWS	I	LEO & OTHER SOLAR SYSTEM SCIENCE
	NEW RESOURCES FROM SPACE	M	LUNAR SURFACE/MARS MOONS/ASTEROIDS
COMMERCIA-LIZATION	OPTIMIZE INDUSTRIAL ACTIVITY	M	LEO & GEO OPERATIONS
	HAZARD REMOVAL	M	LEO, GEO & CISLUNAR OPERATIONS
	ENERGY FROM SPACE	M	GEO & CISLUNAR OPERATIONS
	NEW RESOURCES FROM SPACE	M	LUNAR SURFACE/MARS MOONS/ASTEROIDS
EARTH APPLICATIONS	AGRICULTURAL, FORESTRY, AND FISHERY MANAGEMENT	M	LEO & GEO OPERATIONS
	PROTECTION OF ENVIRONMENT	H	LEO & GEO OPERATIONS
	AID TO INDIVIDUALS IN PERIL	H	LEO & GEO OPERATIONS
	AID TO CRIME CONTROL	H	LEO & GEO OPERATIONS
	AID TO INTERNAL SECURITY	H	LEO & GEO OPERATIONS
	IMPROVED GOVERNMENT	H	LEO & GEO OPERATIONS
	ENERGY FROM SPACE	M	GEO & CISLUNAR OPERATIONS
	NEW RESOURCES FROM SPACE	M	LUNAR SURFACE/MARS MOONS/ASTEROIDS
	INTERNATIONAL COOPERATION	H	LEO & GEO OPS/LUNAR BASE/MARS MISSIONS
EXPANDING PRESENCE	SPACE HABITATION	M	LEO & GEO OPS/LUNAR BASE/MARS MISSIONS
	NEW TECHNOLOGICAL CAPABILITIES	M	LEO OPERATIONS
	NEW RESOURCES FROM SPACE	M	LUNAR SURFACE/MARS MOONS/ASTEROIDS
	HAZARD REMOVAL	M	LEO, GEO & CISLUNAR OPERATIONS
	INTERNATIONAL COOPERATION	H	LEO & GEO OPS/LUNAR BASE/MARS MISSIONS
	PROMOTION OF INTERNATIONAL PEACE	M	LEO & GEO OPS/LUNAR BASE/MARS MISSIONS

* I = INTELLECTUAL M = MATERIALISTIC H = HUMANISTIC

FIGURE 14

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where are we going -- and the materialistic ones (indicated by M) are the best understood ones of the three types, as I said. Typically, they include the interest of investors to make an honest buck by utilizing the new resources of space such as putting appropriate industrial activities into weightlessness. And there is the big H, the humanistic benefit, which has to do with the human in us, with everything which makes us human and helps us to survive in dignity. Eventually, even just having fun in space is a humanistic benefit. But today, we can't even talk about it; people would consider it frivolous. Just imagine what Congress would say if we were to attempt to sell a long-range program on primarily humanistic reasons. On the other hand, I can't close my eyes to the fact that the intellectual and humanistic benefits are the ones that hold out strong motivation to other societies and civilizations on Earth, even if we in Western society perhaps aren't quite there yet. That's why eventually we need other countries and especially the developing countries of the Third World to participate -- after we have helped them out of their miseries.

The next slide (Figure 15) shows the domains which the previous picture indicated as beneficial in the various areas. As we can see, they are intersecting. The central domain, of course, is our Space Station in low-Earth orbit (LEO) from which we can proceed to advanced low-Earth orbit and other Solar System science missions, such as large telescopes and the exploration of Jupiter or unmanned probes to Mars for samples. And we can go on to geosynchronous and cislunar orbits, or to the moon, or to Mars. These are manned missions, and the reason their domains are overlapping is that they are related by energy requirements, mission profiles and systems capabilities. For example, you can go to Mars by way of the geosynchronous regime or you could go there directly. The main message here is that it is going to be a big, complex, interlinked and intertwined network-type of world out there in the future beyond the Space Station. We really cannot look at the future any more with our old naive "either/or" attitude which came from Aristotle. It's not going to be that type of world. It's going to be a world of options,

POST–SPACE STATION MISSION DOMAINS

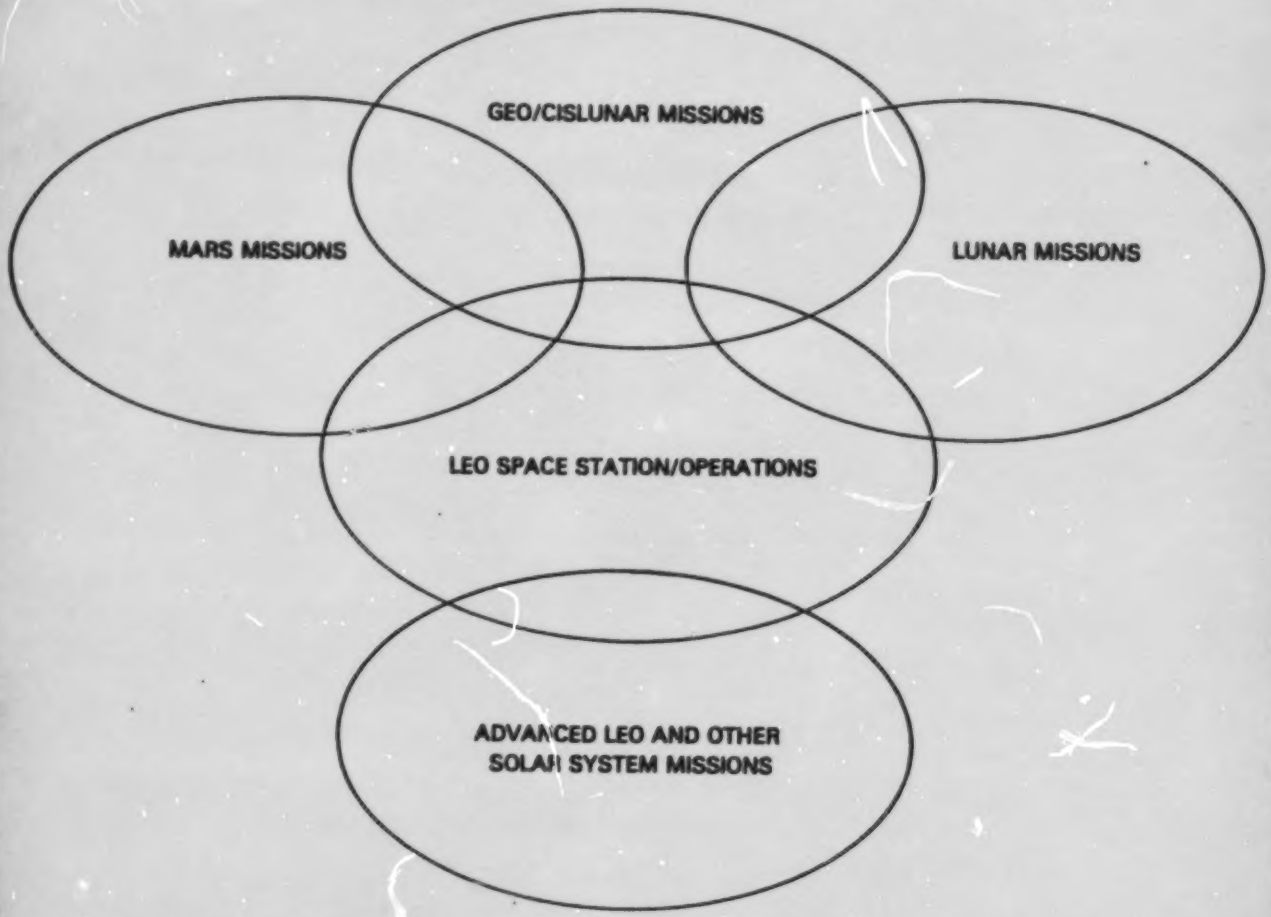

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FIGURE 15

of multiple objectives, and the things we are going to do will require us constantly to balance opposing and changing views. We are not going to do "either" this "or" that but we are going to do "both" at a certain point of that balance beam. That means we will have to learn how to negotiate, how to understand the other person's viewpoints and how to put ourselves into the other's moccasins.

To get us away from this ancient either/or type of thinking in preparation for the 21st Century is clearly a challenge to education, the task of teaching kids how not to be "either/or". They'll simply have to learn that the world is full of paradoxes. They'll have to be able to think "both/and" -- that is, in complementary logic, while being taught mathematics at the same time. Yes, that too is a paradox but it needs to be done in order to prepare them for the future.

As we go out to geosynchronous orbit with people, we will have to provide some kind of a construction shack out there in which space crews will stay temporarily, perhaps a couple of weeks or so (Figure 16). The environment at geosynchronous altitude is quite harsh; radiation is considerably higher than in lower orbits because the protective magnetic field of Earth gets rapidly weaker at larger distances. Thus, we need heavier shielding, and people will not want to expose themselves for too long to avoid accumulating radiation dosages that may shorten their useful lives as astronauts.

NASA has done a lot of studies about going back to the moon (Figure 17). Again, there are lots of benefits to this but as you move away from the useful nearer-orbits of Earth the initial reasons for doing so have to be other than purely materialistic ones.

There is clearly a synergy here between the down-to-Earth applications of space and the growing maturity of people in understanding why the longer-range exploration at greater distances should be undertaken. Space exploration will cause people to grow internally. It's almost like

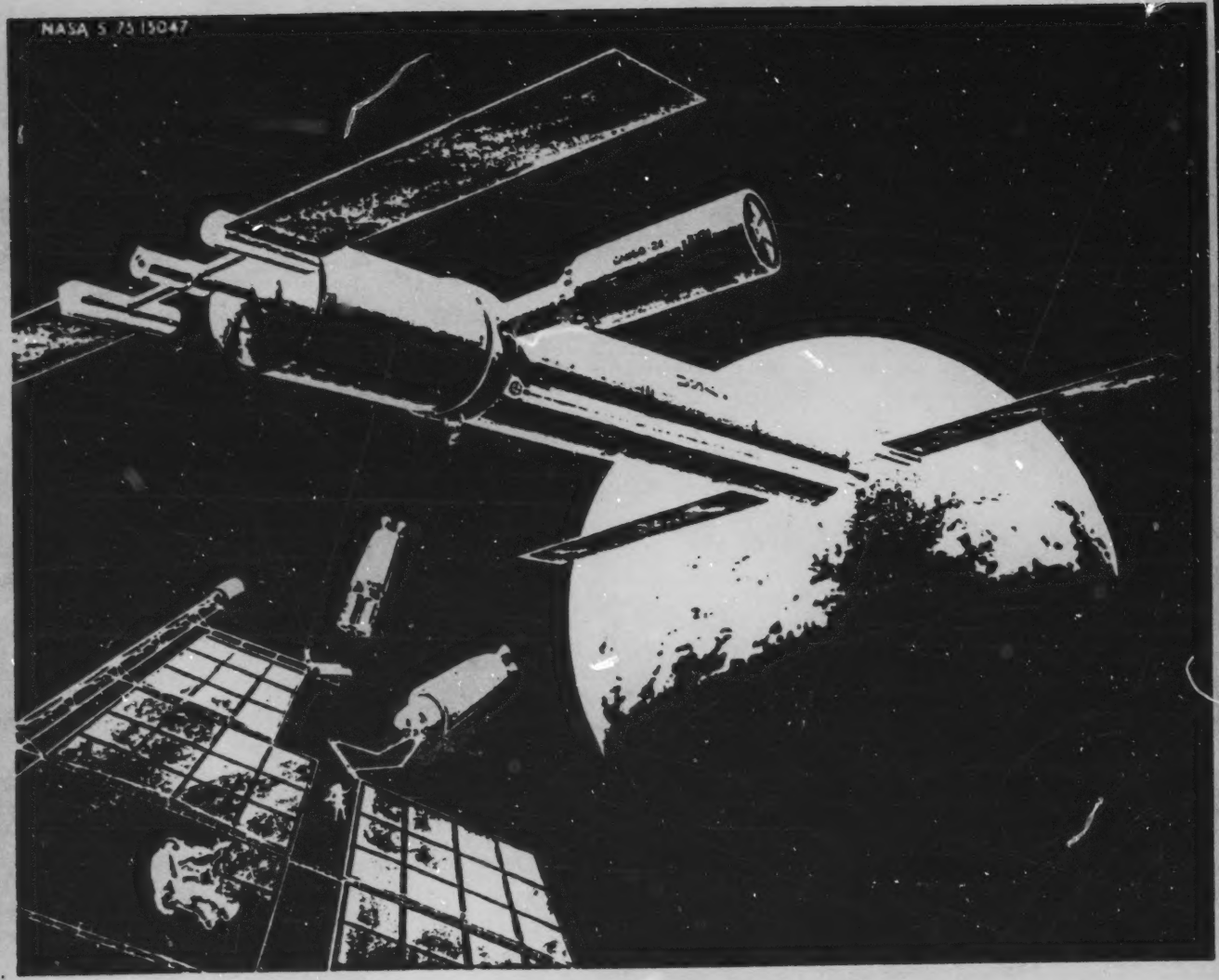

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FIGURE 16

POSSIBLE MAJOR GOALS OF LUNAR COLONIZATION

- UTILIZATION OF THE UNIQUE LUNAR ENVIRONMENT FOR RESEARCH AND TECHNOLOGICAL DEVELOPMENT.
  - LOW GRAVITY
  - REMOTENESS (ISOLATION)
  - VACUUM
  - LOW BACKGROUND NOISE
  - EARTH OBSERVATION
  - LARGE TEMPERATURE VARIATION
  - LOW MAGNETIC FIELD
  - LONG DAY/NIGHT CYCLE
  - STABLE STATION/PLATFORM
  - UNIQUE GEOLOGICAL FEATURES
- UTILIZATION OF LUNAR MATERIALS FOR SPACE INDUSTRIALIZATION
- ADVANCEMENT OF OUR UNDERSTANDING OF SOLAR SYSTEM AND ITS ORIGIN
- INITIAL SPACE COLONIZATION EFFORT: EVALUATION AND EXTENSION OF MAN'S CAPABILITY IN SPACE
- EXPANSION OF OUR UNDERSTANDING OF MAN'S ECOLOGY
- EXPANSION OF OUR UNDERSTANDING OF HUMAN INTERACTIONS AND PSYCHOLOGICAL PROCESSES
- STIMULATION OF CREATIVITY IN ALL FORMS
- PROVISION FOR THE OPPORTUNITY TO DEVELOP NEW FORMS OF SOCIAL, POLITICAL AND ECONOMIC STRUCTURES
- ENRICHMENT OF OUR LIVES

FIGURE 17

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a natural law: For every step you take externally away from Earth, you'll take an internal step closer to your inner self, becoming a different human -- perhaps even a better one.

As for the reasons for a lunar base, in the beginning it'll probably be the quest for knowledge -- and it is up to you educators to instill that quest in the kids for the decades after the year 2000. The hunger for the new, the curiosity, the sense of wonder of what's out there -- I call it the "Ignorosphere", and it's growing all the time. You could say we are not really acquiring more knowledge about the Universe by flying out into it -- we are just increasing our awareness of our ignorance, of how little we know about it. And so, because the picture we are getting of Creation is increasingly awesome, our concept of God is growing the more science explores space.

The chart shows a number of reasons for a Lunar Base. There is the advancement of our understanding of the Solar System and its origins. It would be an initial space colonization effort. We could evaluate and extend man's capabilities in space and understand our ecology, expand our understanding of human interactions and psychological processes, stimulate creativity in all forms, provide for the opportunity to develop new forms of social, political and economic structures, and altogether enrich our lives.

The technologies required are well understood (Figure 18). We have already been on the moon six times with men; we can go back easily. We'd need some kind of Lander, a better one than the Apollo Lunar Module, but it would be a member of the family of what I called the Orbital Transfer Vehicle. There is synergy between systems and elements in that hardware developments for going to geosynchronous orbits could also be used for a Moon program with minimum modifications, or even be adaptable to a Mars mission -- if we do it right. That's why we have to look at the entire field of projects beyond the Space Station -- to get a better understanding of the commonalities and synergisms of the long-range missions enabled by it.

FIGURE 18

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On the moon you would put your station underground because the lunar soil makes an excellent natural shield against radiation, heat and cold. Lunar soil, with a hard vacuum between its sand grains, is a natural insulation substance. Thus, to start a Lunar Base, we would dig ditches with an earth mover/crane, a combination-type system with a front-end loader that could also pick up the base modules flown in on the Lander, place them in a ditch, and cover them over with dirt (Figure 19). There'll be airlocks and a small pilot plant to experiment with techniques to produce oxygen and water -- almost like Moses -- from lunar minerals, especially from an iron/titanium oxide called ilmenite. There are several methods by which that could be done, and we would have to experiment to find the most economical one.

Eventually there would be settlements on the moon -- today, still pure science-fiction (Figure 20). I prefer the word settlement to colonies or colonization; for the Third World, colonization conveys a negative psychological image -- that someone is being "colonized" by someone else. The picture shows a model study by two architects, Dossey and Trotti, done several years ago at Houston, Texas, of what a lunar settlement for 200 to 300 people might look like.

What about Mars? The next slide (Figure 21) shows a project which NASA is now getting pretty serious about. It's called the Mars Geoscience/Climatology Orbiter, and it was approved for Fiscal 1985 to the great excitement of our scientists. It would be launched in 1990, and it would consist of a huge orbiter spacecraft circling Mars studying surface conditions and the changing climate, and looking for water. Thus, it'll be kind of a scout for a possible subsequent program of getting people to Mars.

The reasons for going to Mars, even more than those for returning to the moon, have a lot to do with the widening of knowledge and science -- i.e., with further evolving our consciousness and complexity and extending our reach. There is nothing materialistic about

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LUNAR SURFACE BASE
MODULAR SPACE STATION DERIVATIVE CONFIGURATION

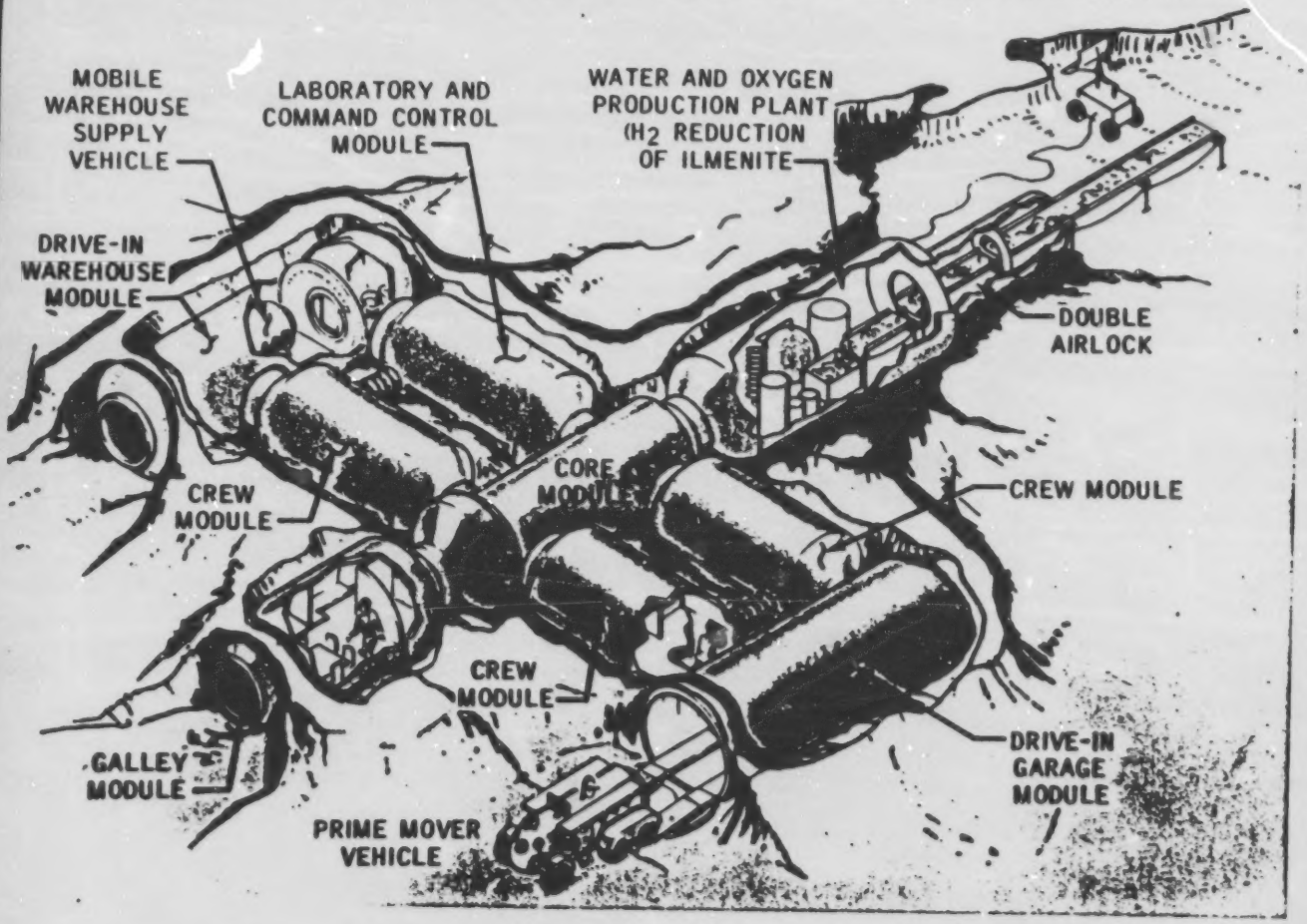

FIGURE 19

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FIGURE 20

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FIGURE 21

it any more; in no way could I tell you that you have to fly to Mars to get rich. But it may be a matter of survival in the long run. The chart (Figure 22) shows some of the reasons. Science: the study of Mars is essential for understanding the evolution of the Earth and the inner Solar System. Habitation: we would determine the existence of life on Mars. Even after the two Viking lander missions, we really don't know that yet. There is an atmosphere, there is an accessible surface, there is water at the poles and probably underground, and there are moderate temperatures. We would investigate the potential for human life support by making air and food and fuel and fertilizers and building materials from the atmosphere and soil of Mars. In addition, a Mars outpost would be a gateway to exploration of asteroids, of Mars' moons Phobos and Deimos, and of points beyond, as well as a base for exploitation of asteroidal resources and for pioneering a future human settlement program.

Mars studies at NASA go all the way back to the Sixties. The next picture (Figure 23) shows a Mars expedition ship, designed when I was with Dr. von Braun in Huntsville. The year was 1968, and von Braun was quite determined about it. It would have used the Saturn V launch vehicle of that time, with a diameter of 33 feet and 250,000 pounds' payload capability to Earth orbit. Today, a Mars expedition would still look like that, but since the Saturn V is no longer available the question is how we would launch into orbit the individual rocket stages of the total assembly. Well, it could be done even with the Space Shuttle. The Shuttle's cargo bay, of course, is pretty small, only 15 feet wide. But the Shuttle could be modified to become what we call an SDLV, a Shuttle-Derived Launch Vehicle, which would be useful for lots of other reasons, including military ones. It would be a big unmanned booster using Shuttle technology, thereby coming in rather economical and providing better launch capability for other missions as well, such as a Lunar Base. Thus, technologies are not that far out of reach today.

The next picture (Figure 24) is a recent painting by artist Paul Hudson of what a Mars landing might look like. Back in the Sixties when Dr. von Braun proposed the Mars project, we didn't really know much

MARS EXPLORATION PROGRAM

RATIONALE

SCIENCE

- **THE STUDY OF MARS IS ESSENTIAL FOR OUR UNDERSTANDING OF THE EVOLUTION OF THE EARTH AND THE INNER SOLAR SYSTEM**
  - CHEMICAL & ISOTOPIC COMPOSITION AND PHYSICAL STATES
  - BROAD-BASED PLANETOLOGICAL CHARACTERIZATION
  - INTENSIVE STUDY OF LOCAL AREAS
  - STRUCTURE AND CIRCULATION OF ATMOSPHERE
  - NATURE AND DYNAMICS OF INTERIOR
  - NATURE OF MAGNETIC FIELD AND UPPER ATMOSPHERE

HABITATION

- **DETERMINE THE EXISTENCE OF LIFE**
  - ATMOSPHERE
  - ACCESSIBLE SURFACE
  - AVAILABILITY OF WATER
  - MODERATE TEMPERATURES (−120° TO +20°C)
- **INVESTIGATE THE POTENTIAL FOR HUMAN LIFE SUPPORT**
  - AIR AND FOOD
  - FUELS
  - FERTILIZERS
  - BUILDING MATERIALS

OUTPOST

- **GATEWAY TO EXPLORATION OF ASTEROIDS AND MARS MOONS**
- **BASE FOR EXPLOITATION OF ASTEROID MATERIALS RESOURCES**
- **PIONEER BASE FOR FUTURE HUMAN SETTLEMENT**

FIGURE 22

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MANNED INTERPLANETARY VEHICLE FOR MARS AND VENUS MISSIONS

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FIGURE 23

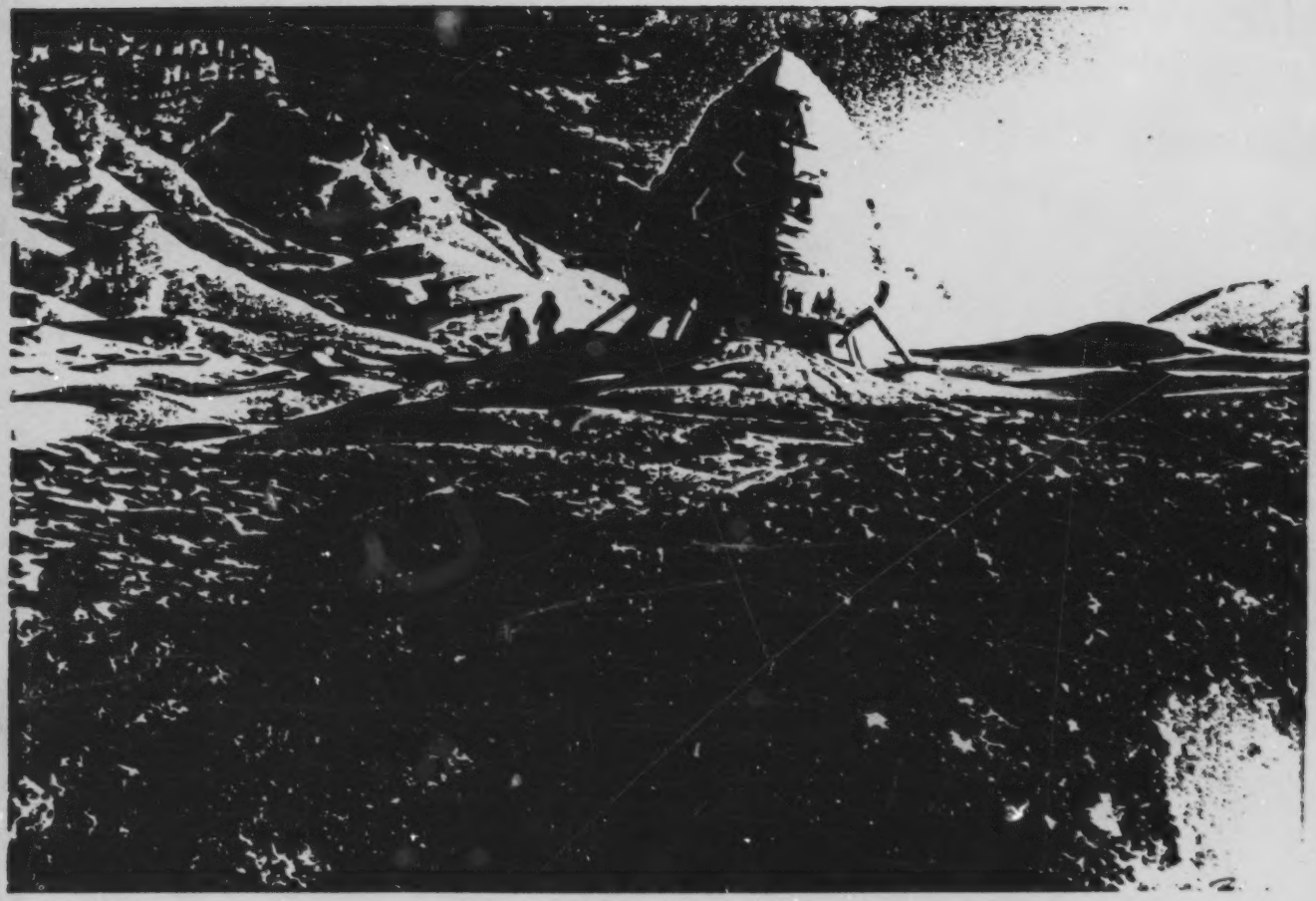

FIGURE 24

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about what Mars looked like. Today, from the Viking pictures we know that not only is its soil a reddish color, but the entire atmosphere is pink because of the red dust suspended in it. We would land our Apollo-type lander on parachutes and terminal rocket engines, and then crew members would emerge and start exploring. They would probably leave some hardware, some infrastructure there for later use. Unlike the Apollo Program, a Manned Mars Mission would not just fly there and back. We would probably plan for a little bit more than that -- such as the eventual establishment of an outpost. The investment to fly out there is so huge that an Apollo-style one-shot mission wouldn't make much sense.

I also don't think the U.S. will be doing it all alone. Nor will the Russians be the ones to do it. It would be immensely easier if done by an international conglomerate of nations, for both economical and philosophical reasons, as an excellent surrogate for war. What if we were to replace our big armament efforts, eventually, with an equally big peaceful cooperative project in space which would be just as challenging as the arms race, if not more so, to technology and science and economy, and to the human spirit?

Summing up then, there are various ways of envisioning the future. All kinds of evolutions of post-Space-Station programs are possible. The next slide (Figure 25) combines a lot of the options on one chart. Today, we are at the point where the Space Transportation System, coming in at the bottom of the left side, is giving us early low-Earth-orbit operations. The next step beyond is our low-Earth-orbit Space Station, with an early Phase 1 and an extended Phase 2. It'll enable us to work toward a large number of long-range goals such as large low-Earth-orbit multifunction complexes for science, applications, and commerce, other Solar System exploration missions, large geosynchronous multifunction facilities for science and applications, manned Mars types of activities and a lunar surface program. This so-called relevance tree shows how everything is connected to everything else beyond the Space Station; but for clarity's sake it does not show that each intermediate

RELEVANCE TREE FOR THE FUTURE OF THE SPACE PROGRAM

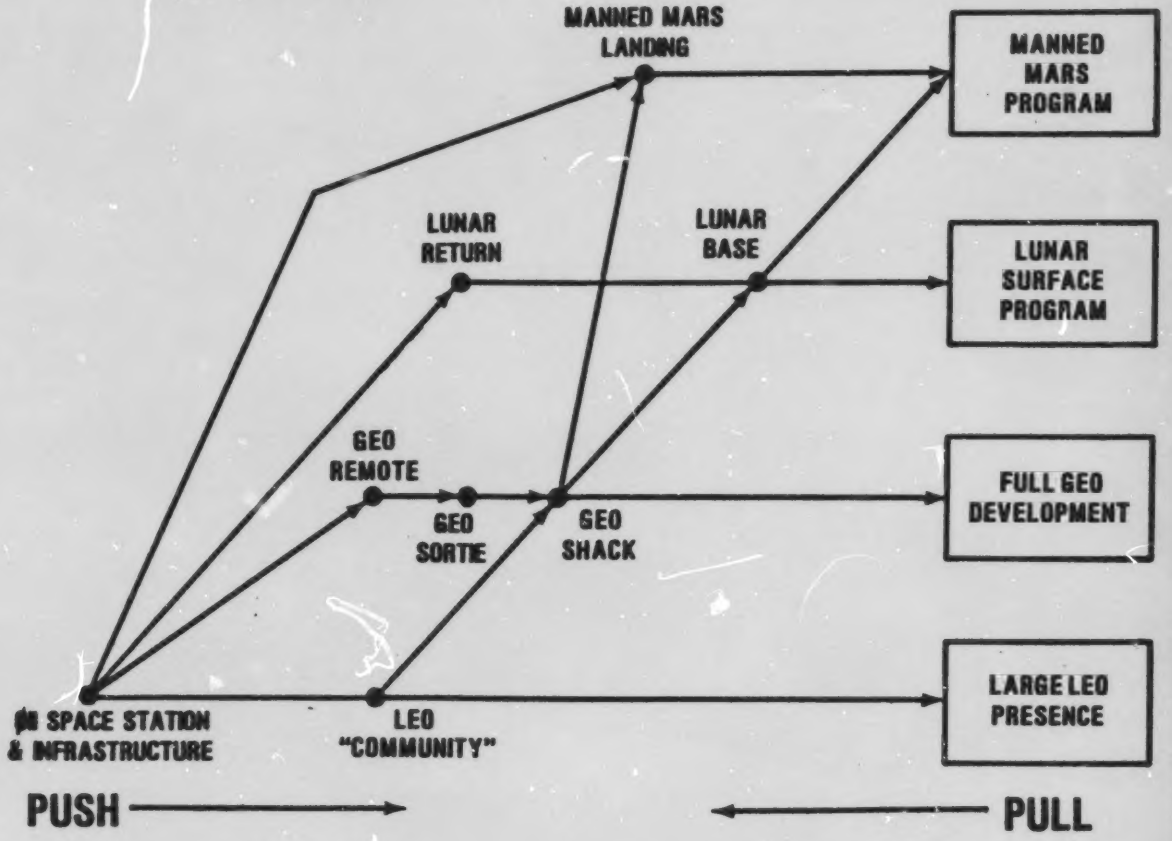

FIGURE 25

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stepping stone reached by us in our progress won't just disappear, but rather will continue on its own level and with its own dynamics. There are synergisms and commonalities between these developmental branches, and I rather suspect this means that we won't be just singling out individual isolated goals any more like Kennedy did with the Apollo lunar landing. Instead we will proceed on a much broader front, even if slower, doing more or less of everything as economies of commonality and synergy stipulate and contemporary priorities dictate. The eventual participation of other nations in most or all of those long-range programs should also be kept in mind from early on.

In closing, I'd like to leave you with a thought of mine which has to do with man's new place in the Universe thanks to the Space Program. It has helped to remove us from where we stood for centuries, namely at the center of all things, and it has made us aware of how small we really are in the scheme of things. In all of the Western philosophies since Descartes, the human was the absolute center; he was the subject and all of nature around him was the object. He was at the peak, and everything else was under him, to be studied and subjugated. After that split between spirit and science, today we are realizing more and more that the human may be only a small cog in this huge process of continuous Creation, that we may be totally insignificant in this Universe, and that our knowledge is not at all synonymous with wisdom.

Somehow, we will have to bridge over that gap between the two sides of the river -- the intuitive, spiritual side of the mind (which probably involves the right brain hemisphere in the model of Sperry) and the rational side of science and engineering, of the doers (the left hemisphere of the brain). It's a job for Education to help us make the human being whole again. But the difficulty is that while science can be taught from the outside and equations can be memorized, the other side has to develop from within. I'm optimistic and daring enough to think that the sensitivity to develop into a holistic person has been given to every human at birth, but that in many of us it's been suppressed, even killed

off in the early phases of life by customs and by an education which is too rational, too mechanistic.

Such an education is okay if you have to develop a wild continent and build a new society and develop science and get in control of the environment. But we have now been controlling our environment to an extent where we desperately need that small voice on the other side of the mind to tell us how far to go and where to stop. I just can't stand the sight any more of well-meaning engineers blithely building machines which are marvels and miracles but which destroy their environment -- and the engineer standing there saying, "Oh boy, I didn't know what I was doing!" This is just totally intolerable -- and it is education and you educators who have got to help us there. You can't expect this maturation to happen overnight. It will be another generation of humans who'll make it.

But this evolution will have to happen, or we are simply not going to have the kind of future I have described.

DR. WILLIAM HIGGINSON

Since I'm a Canadian, I feel a little bit like the intellectual version of my fellow citizen who's going into space shortly. What I would like to do is make a few introductory remarks and go on to what I consider to be my thesis for the morning. I'm very impressed by the organization of this conference; with its emphasis on things like long-term continuity and its involvement across institutional and diciplinary boundaries, what the F.F.E. organization is doing is precisely the sort of thing we have to think about doing in education in the future.

NASA is in a class by itself among institutions of its type. I was enormously heartened by the strongly humanistic comments made by Mr. von Puttkamer. He said that we can't concern ourselves just with putting pieces of aluminum into space. I'm going to make an analogous argument of sorts and say we can't think about just putting microprocessors into classrooms. We have a tendency in this culture to suffer from a bad case of ultramaterialism, and in this case we can call it technolust. I felt marginally guilty when I saw the details of the program because I wasn't going to talk specifically about the snazzy toys that we're trying to produce at MIT, but rather to talk about the human dimension. With the precedent that Mr. von Puttkamer has set this morning I feel much better about emphasizing the human factor in this general enterprise.

I believe we are just about through what I consider to be stage one of computers and education. I think of that stage as being the naive, romantic stage and it probably started about 1979 for large numbers of

people. I think we now understand that this enterprise is much more complex, much more difficult than we believed back in the days when we thought we could put a Radio Shack machine in a classroom and have social change occurring overnight. We now know that is not the case and we have, I think, a more sober but probably a little bit healthier perspective on what will be necessary for us as educators to do over the next few decades to realize the potential of this incredible technology.

I'm going to talk mainly about computers, but that's shorthand for a collection of devices like video disks and video tapes and that sort of thing. I'm not talking about things like medical technology, biotechnology, nuclear technology and so forth, although those are obviously important issues in our general approach to education.

My thesis today has four aspects. First, the rate of change of this technology is quite staggering. We're trying to take an animal which has evolved very slowly over a long period of time and have them cope with a technology which is changing extremely quickly. My second point is that realizing this potential is going to be extremely difficult, and very frustrating. I think some of you who have been involved probably already know that.

The third point has a very obvious piece of jargon which I happen to like. The critical point in the process is warmware, as opposed to hardware and software. I think our first tendency was to try and buy as many of the biggest, fastest, snazziest and most powerful devices we could get our hands on. Some of us then discovered that these things were just expensive and elaborate doorstops if we didn't have something called software to run on them. And even more recently, some of us have begun to realize that even with powerful hardware and sophisticated software, if you don't have people -- and in our case since I'm talking mainly about educational institutions if you don't have teachers -- who are knowledgeable about the hardware and software and who are commited to its use, then you're not going to get very much in the way of significant educational change. And my fourth point is that the recent history of Logo provides us with a rich case study of the above points.

I want to move now to some general themes and issues in which I sort of fill in this thesis and then come back to the idea of Logo. First a set of comments on themes, or issues; these are general aspects of social and technological change, and I have identified about five of them here. They're somewhat arbitrary and there's a great deal of interaction between and among these themes. I am taking something of a media point of view on this. Those of you who know John Naisbitt's book called Megatrends* will recognize this technique, which is that the things which are interesting us as a culture at the moment are getting coverage in our various forms of the media. I think Naisbitt took mainly newspapers, but that's a relatively dangerous game. Our media -- both the classical print type and the modern electronic type -- have a vested interest in reporting relatively extreme forms of issues and that I think brings with it a lot of problems.

Change is certainly characteristic of our culture. We are involved in extremely rapid social change which is presenting us as educators with some substantial problems. These problems are not unique to educators, by the way; if we decide not to continue in education, we'll face many of the same issues in any other part of the culture. So the first general issue is this media emphasis on the information revolution. The most popular version of this is associated with Alvin Toffler's book The Third Wave, which identifies three watersheds in the cultural evolution of our species: the agricultural revolution, the industrial revolution and the information revolution. Toffler's earlier work, Future Shock,** speculated about the future and became a best seller. One little device he didn't predict in that book was the microprocessor. So that's just one indication of how difficult it is to predict the future in this area.

We talk very blithely about revolution as if it's going to be fun. I'd like to do a talk sometime entitled "Whatever made you think

*Naisbitt, John. Megatrends: Ten New Directions Transforming Our Lives. 1982.

**Toffler, Alvin. Future Shock. 1970.

being in a revolution would be fun?" I think if you could talk to someone who had survived another type of revolution they would describe it in many ways, but fun probably wouldn't be one of them. Excitement may well be one of the characteristics, but I think almost every revolution brings with it frustration and emotional strain, and I don't see this one as being very different. Dr. Byrne, who will speak at the conference later today and again tomorrow, has taken the Toffler image of a wave and used it in a very effective image by talking about surfing the third wave. That's very well if you have a Californian orientation and happen to have your surfboard by your side.

The second general theme which is currently prevalent and which is a difficult issue for those of us who work in education is the very common media treatment of the crisis in education. I might say as an outsider, by the way, that you in the United States seem to have an extreme form of this particular trauma. That is not to say that those of us in other parts of the western world don't have it, but it doesn't seem to be quite as severe in my native Canada or in western Europe as it is here. You're all aware I'm sure of the spate of reports that have appeared over the last year and a half put out by people like the Carnegie Foundation and well-known educational writers like Theodore Sizer and Ernest Boyer. Before coming here on the plane last night I stopped in at the newsstand. The front cover of Newsweek this week is "Why teachers fail, how to make them better", and the illustration is a dunce picture. That's the sort of thing that makes you feel good as you head off to your classroom in the morning.

The third issue which is prevalent and which is the one which tempted me to use the title "No Fuel Like an Old Fuel" was the issue of the Japanese challenge. This comes out of the quite incredible record that the Japanese have had over the last two decades in the area of automobile and consumer electronics. Because of that success, people -- particularly those associated with similar industries in other parts of the world -- have called into question their own methods of production and so forth. And again, it's in the United States that there has been

a particularly high level of national soul-searching going on. One version of this was a set of books which contended that what we should be doing is essentially trying to transform ourselves into Japanese culture. We should determine how they do it and then we should try to imitate them.

After that wave of books appeared, there was a second wave, if you will, which I think is rather more healthy and more realistic. The best known example of those materials is the very popular book by Peters and Waterman called In Search of Excellence*. And the argument in that book is that to try to transform American culture into Japanese culture for the purposes of producing better consumer goods is probably a futile task, and that what we should try to do instead is see what it is that effective American companies are doing. That book has become one of the best sellers of all time over the last few years.

What they discovered was that companies with a very strong record of production and success -- IBM, Hewlett Packard and some others -- are simply practicing traditional American virtues. Those virtues are ones like emphasizing action, rewarding people for taking initiatives, not getting caught up in strictly formal hierarchical bureaucratic setups but rather working in small groups, and encouraging a great deal of discussion among people in those groups. One way of looking at this is that these businesses in many ways are putting into practice many of the principles which underlie fundamental political concepts of democracy -- a high emphasis on participation, activity and so forth. What they're getting away from, unlike the businesses which Peters and Waterman indicated were in some difficulty, are very formal long-term plans where people in responsibility remain far removed from the people who are trying to implement those plans.

What I want to argue here, and it's the reason for my title, is that we have here perhaps the best example of what we should be trying to take from the area of business. Education in my view has not had the best relationship with business models in the past. What I'm referring to is

*Peters, Thomas J. and Robert H. Waterman, Jr. In Search of Excellence: Lessons from America's Best-Run Companies. 1982.

our tendency in the past to look at education as production and to make measurement and efficiency our paramount values for education. So we decided it was best to have very large schools because we can optimize on the capital involved with specialized shops and that sort of thing. I think that particular approach disregarded some other values, the sort that Mr. von Puttkamer talked about, and was not a healthy one for our society. This emphasis on traditional American values is the one which we should be trying to replicate in our educational system. If we look at the average school system, the average classroom, these virtues are not valued. I think we could improve things in a number of ways if we were to try this approach; in fact, I would speculate that the schools with which parents are most satisfied have been ones which have utilized such an approach.

The fourth issue of the five which I have identified as being significant and prevalent in this area is this question of the effects of technology on humans. There are several different aspects of this. One comes out of the quest which is called artificial intelligence. Going beyond information technology for a minute, our culture has been characterized in recent years almost completely by the nature of its technology. People like Lewis Mumford have been extremely critical of what this emphasis on technology has done to our culture. The eminent historian Daniel Boorstin, who is now the Librarian of Congress, wrote a paper ten years ago on technology -- and here he was thinking of things like television and automobiles, not so much things like personal computers. He said technology has three characteristics: Technology isolates, it centralizes and it homogenizes.

Now depending on the set of educational values you have, you can be more or less alarmed if you believe that Boorstin is correct in his analysis of the effects of technology. My personal view is that although he may well be correct in his general comments here, information technology, particularly in its form of personal computers and related devices, in many ways pulls against that general tendency. One of the

human fears about technology (and in education it's interesting that we have mixed feelings about it) is that technology will render you unemployed. In education we are ambivalent because on the one hand we are afraid as educators that we'll be made redundant and unemployed; but on the other hand, there's a feeling that perhaps this would be a good thing, that there are things this technology can allow us to do which will be good for us in an educational sense. I think you can take the same position on this which was taken by people many decades ago when things like Skinner boxes were around, and say that any teacher who can be replaced by a machine should be. I think that was true of the Skinner box and it's probably true as well of personal computers.

The last general issue I want to raise is the nature of knowledge and of knowing. This one is much less known than the previous four; if you watch television and read newspapers and magazines, you find many references to the information revolution, to how this is changing us, to automation, robotics, employment, the Japanese talent and so forth. The nature of knowledge, however, is not so often discussed, but it has particular importance for us as educators. Five years ago you could hardly find anyone even on the most prestigious campuses who used the word epistemology. Now, at some conferences at least, it's used in every other paragraph. Epistemology is the study of the nature of knowledge.

This emphasis on what it means to know something and how we come to know it comes from a number of different directions. One strand has been the search for machines which are intelligent, the area of artificial intelligence. My colleague at MIT, Marvin Minsky, was perhaps the father of this discipline in some senses. Minsky has a marvelous sense of humor and is good at throw-away lines. One of his best is "After all, what is the human brain except a computer made of meat?" Another refers to the development of fifth-generation and sixth-generation computers. Minsky says: "If we're lucky, these computers will keep us as pets." Well, that's the sort of thing that drives humanists quite insane. I once heard my colleague Seymour Papert respond to the question

"What is artificial intelligence?" by saying that if it's not artificial, it's real and if it's not intelligence, it's stupidity. So artificial intelligence is anything that's not real stupidity. I think he was joking a little bit, but the idea we're looking at is whether we can produce machines which are in some sense intelligent. And if we can, where does that leave us? Are we just awkward containers for computers made of meat? Or are we something more than that?

There's another way to look at this. A philsopher who is not very well known these days, Ernst Cassirer, a German originally, contended that the thing which made our species unique was its ability to create and to manipulate symbols. Now what computers have done in the 30 to 40 years since Cassirer was writing those things is to take away our uniqueness as far as the manipulation of symbols is concerned. But I think you can take a fairly optimistic view of this area if you say, "now our job is cut back to identifying situations which have meaning for us and which we wish to explore by creating a set of symbols and then when it comes to manipulating those symbols the computers can take over."

Another important figure in this area is the late Swiss philosopher/biologist/psychologist Jean Piaget, who was well known in educational circles 10 or 15 years ago in North America, rather in a faddish fashion I think. The general Piagetian emphasis was on the idea of knowledge as being internally constructed by the learner, by the human. This is in direct contradistinction to our emphasis in most traditional educational psychology on a neo-behavioristic view of things which emphasizes the outside. In other words, if we want this person to learn this, what we have to do is structure the environment in such a way as to elicit the desired responses from the chosen stimuli. If you don't get the responses you want, then the stimuli must have been wrong. But it's entirely an external thing, without consideration for the individual.

The Piagetian view says you have to look at the learner, see him or her as an active agent trying to make sense of the world, and then

go from there to help them build more complex cognitive structures. A couple of quotes here, one I think a very powerful observation of the nature of knowledge which is consistent with the Piagetian position, from the English critic Northrop Frye. Frye says knowledge is not something one has, knowledge is something one is. If you think about the large amounts of money we spend on evaluation -- and almost all our models of evaluation are based on that materialistic perspective that it's something you have, we assess it, we count it, and so forth -- then I think it's quite a profound statement. One other implication of the Piagetian constructivist view of things is that you blur the distinction between learning in a schooling sense, some arbitrary isolated institution where you go to learn facts or whatever, and the things that happen in the day-to-day world.

My final comments have to do with Logo. I don't have time to do any sort of justice to Logo for those of you who don't know it, but it is a direct outgrowth of the Piagetian position in a computer context. The main force behind the development of Logo is a professor at MIT whom I mentioned previously, Seymour Papert. Papert studied with Piaget and sometimes said he was a Piagetian student. Seymour had two Ph.D.'s when he went to Geneva, so I don't think it's entirely accurate to call him a student in that sense. But he developed the computer system which is based on that Piagetian position which puts a great deal of emphasis on the activity of the student, student-initiated activity, discussion, cooperation and so forth. Over the past several years, as far as most people have been concerned, this has become one of the major areas of discussion in the computer education world.

People have strong feelings about Logo; in some people it engenders great enthusiasm and in other people, great skepticism. I stand somewhat in the middle because I'm very enthusiastic about the potential of Logo but I've worked closely enough in recent years with teachers trying to implement it to say that it's very difficult to realize the potential of this rather attractive tool in the average classroom. What we're trying to do now is find out what is it that characterizes the differences among those teachers who are able to

integrate Logo successfully into their classrooms and those who aren't. I should say here that I use Logo not because I believe it's in any sense the final word, but rather because at the moment it's the only example we have of something which in an authentic sense shows us how to connect to life in the global village, life after the information revolution. I think there are a lot of other very clever things around which in a limited context are exciting and valuable, but nothing which is on the same scale as Logo. If you are not familiar with this area and you would like to follow it up, the book is called Mindstorms, it was published in 1980, it's in paperback and the author's name is Papert.

I'd like to mention a couple of things about Logo. One is that in my view the secret to the successful implementation of Logo is the teacher. Now that teacher may in some cases be an older child or a parent, but given the mechanics of computers in education until now, we're basically talking about teachers. Classroom teachers have an incredibly difficult job and to parachute something like Logo down on top of them and to expect them to do wonderful things with it, is just being naive and not very helpful at all. So the big challenge is to design teacher education programs which can help teachers use this tool.

Two things have come out of my own research over the last couple of years. The first I find quite distressing, and that is that Logo doesn't seem to be different from other materials of this sort as far as gender differences are concerned. It's probably dangerous for a large, aggressive first-born male like myself to say this, but I think we must give priority to this issue because a large number of young women -- and this seems to be particularly severe at the 12 to 14 year-old stage -- are turning off to this technology because of the way it's being introduced to them in classrooms. I see that as a very serious issue, but also one which I'm somewhat optimistic about being able to do something about. And second, in many of the classrooms we've worked in, the social aspects of Logo have been extremely positive. It's much more difficult to pick up the cognitive differences, but the social side of things has been very

positive. Children have been learning to discuss the work of others critically, to make positive suggestions, to cooperate and so forth.

To conclude, I see high technology and education as having both enormous potential and great challenge. The school system we have now is basically set up in a pre-Gutenberg fashion, which is to say that it gives great priority and value to information. We don't need that anymore. Our culture is absolutely suffused with information, and what we now need is to teach children how to handle information. I don't agree with Mr. von Puttkamer's comment that you can knock science into the heads of kids; I think educational research has shown that you can't. A few kids -- enough to staff MIT and NASA -- manage to go through the system on their own but the fundamental question becomes one of equity. Are we talking about a system in which all children have the opportunity to have access to this technology or are we talking about an elite system? That I think is the essential issue.

Let me finish by quoting one of my favorite remarks from the use of Logo by children. It comes from a delightful pair of 8-year-old girls working on a program in Logo to produce a windmill. Those of you who are familiar with Logo know that the girls varied the colors and the size of the rectangles and rotated them and then made bigger rectangles and so forth. Their comment at the end was, "This was hard to do, but it had to be done." I think that may serve as a summary of what educators now must do.

DR. PETER DEMERS

As I walked to the podium with my reels I couldn't help but think of my teaching days when I would say, "Oh, God, I don't have to teach today, I've got a film!" What I'd like to talk about today is the notion that if we show films or video or whatever, we are not really teaching. That was pretty much the mindset of most of the people I taught with when a film was shown. It was like: "We'll show them a film about this but then we'll teach them."

This idea catches upon the notion of what education is all about in its most simplistic forms. We think about education being basically the presentation of information and the comprehension of information. And we think about the traditional means that we've used over the years since the printing press, primarily in the development of the German university teaching model.

We assign reading homework or reading in class; the book presents information and then we have a discussion about it. So we're talking about information access and comprehension. Those of you with doctorates in instructional development or curriculum development may take me to task for the simplicity with which I'm presenting this information. But I think essentially that's what we do in schools; that's what we do when we educate.

One of the things that we must remember is that if, in fact, we're dividing up education into those two components, then we need to develop a way to utilize modern technology to accomplish those two tasks. Why didn't I or the teachers I taught with back in South Hadley, Massachusetts, think of that film as a teaching experience? I think it's basically that neither we nor the students were participants. When we go home and watch television -- Nova or Jacques Cousteau or whatever "educational" television experience you get involved in -- we don't think of that as a teaching experience. It may be learning to the degree that information is disseminated, but comprehension is dependent upon whoever is receiving the information. I am probably one of the most naive persons in terms of advanced science and mathematics you will ever find working for a high-tech company. So if I watch Nova or even listen to Mr. von Puttkamer's presentation this morning, my learning readiness to use that information is probably not as strong as that of people who are much more interested and/or able to absorb that information more quickly than I am.

So how do we handle that? How do we take care of making video or film or other visual presentations more learning accessible, make them part of the teaching process? I think now we have the technology to do that. I propose that the challenge to education today is that the role of the teacher and the role of technology are going to be quite different from what they have been in the past. Teachers now must become managers of the learning process. We don't need teachers to give information any more. We have far more sophisticated and far more interesting ways to disseminate information today. Fifteen years ago we had films. What was their weakness? They were not interactive; they were passive learning experiences. Today we have the technology to make those devices interactive. Kids can interact with visual materials.

We don't think of books as visual material but we read them, and we interact with books. You can sit down, read a passage and think about it: "Hmmm, I didn't really quite understand that", or, "I'd like to go

over that." You have a chance to stop, absorb, re-read if you will, check back to another part of the book if you didn't understand or if the preceding material escaped your mind. But film and video as we've traditionally known them were linear presentations -- they just went on. Today with interactive video, we now have the ability to do the same things we did with the book.

In my humble opinion, I think things like microcomputers are a major learning device in schools -- a transitional technology. I think what we must do in schools is to look to a technology that people are comfortable with and understand. And that technology -- whether we like to admit it or not -- is television. I don't know what percentage of American homes now have television; certainly it's the vast majority. A significant majority of homes have more than one television. I read in USA Today that the sale of video cassette recorders has increased 70 percent this year over last. I read in the newspaper this morning that the American Medical Society says what's wrong with medical education is that too much information is given to doctors: the emphasis is on the absorption of information and not how to learn new information. We have to teach kids for what tomorrow is going to be, not what today is, because the world they are going to know will be vastly different from the world we know.

Cranston/Csuri Productions is the name of the company I work for. Our company has won awards in Tokyo, London, Monte Carlo, New York and Los Angeles, and this is a young company -- three years old, two years in production. I was hired a year ago because this company has a strong commitment to the use of their technology in the education field. The company was started by a man who has been an art professor at Ohio State University for 35 years. In about the mid-sixties he began tinkering with the idea of a computer drawing pictures.

When you think of computer graphics, most people think of the stuff you see on the Apple -- the Pac Man games where little figures run around. That

is not what I'm talking about and I'm not here to talk about the development of computer animation or graphics systems for kids to use in school. I'm talking about an animation process that allows the illustration of concepts and ideas far more effectively than we've ever been able to dream of doing it. Why? Because we are now able to draw pictures in three dimensions. We are now able to depict ideas and concepts that we've never been able to depict before, because the computer knows no boundaries.

I want to take just two minutes to explain the process. Since I have only a simple understanding of the process, it's very easy for me to simplify these explanations. When I was a child, I used to love those little books where you had the numbers and you drew lines to each of the numbers to get your picture. Well, that's what this process does, in its very simplest form. The difference is that the computer draws those numbers on a much finer scale, and it also draws them not on just the x and y coordinates, but on the x, y and z coordinates.

If you wanted a picture of the object I'm holding -- it's a wireless projector control -- you can take a photograph of it or you could have an artist draw it. But if you wanted the ability to look at that object from every conceivable perspective with every conceivable light source, how could you do it? I guess if your artist had an infinite amount of patience you could have that person think of the number of different dimensions that this simple little object has. It would probably take a very long time, but it could probably be done. But when the computer draws, since it uses three dimensions, this entire object is drawn -- the entire object is put into the computer. Therefore, when you want to look at that object in a different dimension, with a difference light source, you merely manipulate that object by the computer.

What are the implications of that for education? Well I think if you think about that you realize that the number of concepts and ideas you will be able to illustrate will be practically limitless.

Now remember, even though my company is very interested in education and training, I have no background in computers or business or anything similar. A year ago this company hired me because they felt strongly about the use of this technology in education. But the company still has to survive and it is surviving now principally on the commercial market. What you're going to see -- and not because it's the company I work for, but because we are acknowledged around the world -- is the highest level of animation possible by a computer. It is composed of some material that you've seen on commercial television because we do a lot of work for ABC, NBC and CBS, and also some commercials, but also some of our research pieces which explain the technology a little better.

To conclude, I think the animation speaks for itself. The application of the animation capabilities I think are practically limitless. That combined with interactivity if we can develop curriculum that uses interactive video and this level of animation; our animation is best used for showing dynamic processes. If you need a picture of something, take a picture; if that's all you need, that's fine. But if you need to show dynamic processes, you need this technology. A doctor in San Francisco at a conference I presented to a couple of months ago said, "Your animation can show me something that I've never totally understood. I understood it intellectually but I never comprehended it." That's what our animation is all about. Its capabilities are limitless.

DR. LYNN BONDURANT

It was a great morning when you stop to think that Jesco took us into the next century, and then Bill pointed out how this new technology is going to offer to educators unparalleled potential. Peter showed us that with this technology there are really some horizons and we're able to do some things that perhaps we never imagined we could do. In the next few minutes what I'd like to do is tie some of this together, let you know some of the services that NASA has for educators, and tell you how we are going to begin to involve high technology. It's going to impact many classrooms across the nation.

I think I heard Ralph mention this morning that Lewis is responsible for doing the educational program in six states: Minnesota, Wisconsin, Illinois, Indiana, Michigan and Ohio. And so it keeps us pretty busy when you stop to think you have a small education staff, as well as two fellows who travel our six states trying to get things done. So more and more of what we're trying to do is to focus our efforts. One of my favorite ways that we work with educators is through workshops. And if some of you throughout the state want to organize some workshops we'll plug it into our schedule in the months ahead. To us that's a very important priority.

We have in the summertime aerospace education workshops throughout our six states. Last summer we had an aerospace workshop at Xavier University, the University of Toledo, Wright State University and the Air Force Museum, as well as here at Lewis. We have a workshop here on center every year, and one of the things that we want to begin to do with our on-center workshop is have one week of it here at Lewis and the

second week of it at Cape Kennedy, which will be a unique opportunity. So we're beginning to build towards that, and all of the participants will get college credit. For the first time this summer, we had a different kind of workshop called New Mast, an educational workshop for science and math teachers. Every NASA center had this workshop this summer, co-sponsored by the National Science Foundation and the National Science Teachers' Association, as well as NASA. This is a different workshop in that the teachers work with the scientists and engineers on a more personal basis than our on-center workshop, where we try to demonstrate how you can teach aerospace concepts in the classroom. So aerospace education workshops are a very important function to us.

One of our pride and joys at Lewis is our teacher resource room. And if you haven't seen it, I hope before you leave today that you will make every attempt to get over to the second floor of our visitor information center. In our teacher resource room, there are over 4,000 slides, 400 videotapes, and file cabinets filled with lesson plans, film strips and audiotapes. As educators you can bring in a blank videotape and copy the entire collection if you want. Or you select the slides you want, pay for the cost of the film, and we process it and send you the slides. We're currently in the process of establishing regional teacher resource rooms throughout our six states. At our own teacher resource room we are servicing about 300 teachers a month and with our goal of having 50 such rooms in our six states, we're trying to reach an audience of 50,000 teachers a year. We want to work more closely with the educational community.

We're going to give a program called Education for States. As NASA conducts experiments aboard the Spacelab or the Shuttle, that information will be broadcast to schools in the United States. Imagine the astronauts taking a measurement in space and the signal from that being sent down to the telephone system, where that signal is sent out nationwide to any school that wants it. You're right there getting instantaneous feedback from space, and have the students simultaneously taking measurements.

Information Access Systems -- what lies ahead is exciting. Probably two things are going to come into being. A network you will call similar to TelMed, and you might say "Space Telescope", and you'll get a recording as to the latest developments with the space telescope. The other will be a computer system with which you can access any of NASA's information from your own personal computer or the school computer. If, for example, you wanted to know what the "K" stands for in Sally K. Ride, you can punch that in and find out. Also at Lewis we're developing materials for the handicapped, particularly the visually and hearing-impaired students. One of the things we'll have available probably within two months are NASA videotapes captioned at three levels of reading difficulty. No other NASA location is doing this.

I hope all of you think of ways you can work with NASA as well. We like to get involved. If you know anyone who plans to do a dissertation and might be interested in doing it on a subject we have materials on, I hope you'll have them get in touch with us. We've done several studies to date. One is taking a look at all our educational materials and how applicable they are to education. We've just finished another study on teachers' perceptions in the state of Ohio in teaching aerospace concepts. I'm working now with someone from Ohio State University who's doing a dissertation on NASA's impact on the fine arts.

For the first time we have this year a graded school program. Be sure to bring your students to our visitor information center.

DR. RICHARD BYRNE

Do you believe all this stuff? I mean, do you believe this stuff about computers and holography and satellites and teleconferencing? Do you believe we're really in an information age? Let me tell you about the problem with educators. My biggest problem with educators is that many of them are terminally intelligent. There are so many bluffs, and they know all the language, but there's no reality. It's not real for them. For most of my corporate clients, it's real. They know that if they're not on top of the third wave, if they're not certain, if they're not up front, if they don't make a decision, they lose market share. And when they lose market share, they lose money, and when they lose money they go broke and they all go look for jobs.

Educators aren't under exactly the same kinds of pressures -- there are different kinds of pressures. I'm an educator too. At U.S.C. I teach computer graphics and all the animation you saw this morning, so I still am in touch with students. The people who know the most are the most unconscious of any people I deal with: Teachers. I'm absolutely serious about this because I'm concerned about teaching.

I'm even more concerned about learning. What masquerades as teaching really gets in the way of learning. We ought to be facilitating learning instead of becoming better and better teachers. But that's another speech.

This is a two-year-old technology that I use to run my own company. The company's very successful and I'm never there. I'm never

in the headquarters. I live in Los Angeles, and our corporate headquarters are in Timaron, on the north shore of San Francisco Bay, because all the staff wanted to live in a nicer part of town than I do. They answer all my mail, they abstract every letter and every incoming telephone call into one line. I have already communicated to them my priorities; they know me in and out. They know what I want to do, what I don't want to do, how much I want to charge. So my agent is free to make decisions on my behalf, and I am obligated to fulfill them. She books me. Monday I gave two speeches -- one in Phoenix and one in San Diego. She said, "You can make it. There's a connection." So I couldn't say no. You see, the agreement has to be made up front.

The technology, though, facilitates. You're in business in a completely new way. Completely new. This is not just typewriter to word processor to portable. This is a new way of working. Because we work in a new way, we are empowered. Our company has mobility, I have free time to come and do this, we have more money, we have more fun. Now someone might look at this machine and ask how much memory it has. This one has 32 K, 32,000 bytes. And they might say, "Funny, it looks just like a computer." When I deal with data processing directors -- people who run the Cray and the IBM 327[illegible] and 3230 and so on -- they are powerfully unconscious when it comes to some other areas. This director's got a job to do; he's supposed to keep the big computers running. Do you have time to stay abreast of every development in microtechnology? It can't be done. So a lot of people like that who are in charge of mainframes in large corporations are not paying any attention at all to stuff like this. Now for a data processing director to look at this and laugh is like two cows walking through a Brazilian river, and one says to the other, "Don't worry about the fish, they're small." This is a transformation.

The point of all this: Is it real for you? Not unless you believe it. How many of you believe there's water in the fire sprinklers in this room? Do you know that there's water in the sprinklers? Do you

know the difference epistemologically between believing something is true and knowing for a certainty that it's true? You stand at the front door, and if it's raining, will your behavior change? You'll look around, or borrow a raincoat, or run; but see, you know it's raining. My belief is that not five percent of educators know we're in an information age. If they knew that, I don't think attendance at such sessions would be optional. It would be critical. They'd be the critical success factors -- how do we cope with an information age? And I don't see that. I see people worrying about which computer to get. Do you know the story about the fox chasing the rabbit? After running a while, the fox says, "Forget it"; and another fox asks him why he quit. "I'll never catch him", he says. "He was running for his life; I was running for lunch."

The Wall Street Journal last week had an article that said computer literacy is for the birds. We don't need courses in school teaching children to use computers. What a joke! Computers are like stereos, they said. Can you imagine having a course in elementary school on stereo tuning? Stereo literacy. Just wait awhile, and pretty soon it's going to be so simple that all this programming and word processing and networking will be so simple it will all be nonsense. Is it true? You ought to have an opinion on that. The current issue of Western Airlines has a bigger story called "The Myth of the Information Age". Shopping from the home and portable computers: In 30 pages they say it will never happen. I do it, and people like me do it, but the masses will never do it. Is it true? You need to figure it out.

You see I don't care whether it's true or not. I just know that if you believe you live in an information age and you are a purveyor of information about that, but you don't own that change, then you are training people to meet challenges that you have not yet encountered. The problem with our times is that the future is not what it used to be.

I just went to a conference of the Iowa Media Education Association or the Iowa Education Media Association. We had a two-hour workshop and I was going to show them how to run some of the available software that I thought would be useful for a teacher. Well they said,

"Why don't you tell us your ideas on such and such." So I'd talk a few minutes about that and then start to do the software demonstration, and someone else would ask me to talk about something else. We never turned the gear on. We had state-of-the-art hardware and software available to us, and we never turned it on. I thought to myself that if we'd just left that room for an hour with the door unlocked all that stuff would be stolen, because there are people who want to learn how to use it.

Do I think technology is the answer? No. I had an interesting conversation recently about this with someone who thought you're either a gear freak who's into computers and math, or you're a macrobiotic, macrame, zen mystic from Vermont. Do you think if Bach and Bethoven were around today that they would not be using synthesizers? Give it a rest. Go study your history -- they were working with the state of the art.

School administrators say, "We're so disorganized we've got to get a computer." No! If you're disorganized a computer will only speed up your disorganization. Get organized first, then get a computer. Find out what you're best at and then get a computer to help you do that even better. The more focused you are, the better the use you'll get from it.

Here's what I want you to do. Get a 3 x 5 index card. On it write what you believe about the information age. Is there one? What is it? What does this mean? How do you know? Fish don't know about water and we don't know about being human. If you walk out of this building and it's raining, you will <u>know</u> it's raining. Your behavior will change. You'll pull up your collar, get an umbrella, run -- your behavior <u>will</u> change. How do you know about the information age? What's your role in it?

My next point is that this is the age of the breakthrough. My purpose in life is to stamp out self-improvement. If you believe in self-improvement, you know it's a slow process. But Berlitz says you can

learn French in ten days so you learn it in ten days. Why? Because you believe it. Years ago no one ran the four-minute mile. They knew it couldn't be done because it would kill you. Then someone did it, he didn't explode, and running the four minute mile is almost routine. Breakthrough is all about changing your mind. Immediately after breakthrough everything is all messed up. Today we were told that NASA will build a multimillion dollar wind tunnel. They have a proposal for next year. Then what? They'll continue with another proposal for the next year. Will it get done? They don't know. There's a lot of uncertainty after breakthrough. Within six months IBM will put out one computer every six seconds and they don't know why people are buying them. The world is changing in my opinion -- and it's just my opinion. If it is changing, you'd better decide what to do about it.

In conclusion, how do you cope with this kind of unprecedented change? We are passing through an era of unprecedented uncertainty politically, economically, socially, and religiously. Nobody knows how it will turn out in ten years. You must allow yourself to be ignorant. Acknowledge your ignorance. Say, "I don't know." Be willing to learn. Go to the source. If you have a problem with your computer you go to the store to get it fixed. But no one there knows how it works. A 15-year-old kid could tell you the answer to your computer problem. They have an intuitive relationship with technology. It's tough to say, "I don't know."

Come from mastery. Don't seek it -- come from it. Then it's easier to learn.

OMAR OLSON

On behalf of the faculty and staff, it's a pleasure to welcome you to Lorain County Community College. It's a privilege and a pleasure to host a conference such as this. I want to take this opportunity to commend the Fueling the Education explosion organization for taking on this avant-garde objective of helping us become more effective in teaching our students for the future. The quality of this conference's speakers and the proceedings of the previous three conferences show the tremendous job this group is doing.

Traditionally, we in education aren't known as the great leaders of change. Talcott Parsons, the organizational theorist, placed us just one notch ahead of churches in our ability to lead in change. Certainly we are not on the cutting edge. But if we are going to help society as our world changes almost exponentially, if we're going to be effective as educators, then we must change, and we must get involved in change. We have tremendous responsibility to impart to our students knowledge and skills they can utilize both when they walk out the door and throughout their lives. Further, we should teach them what will help them live more human lives.

As you walk our campus, some of you may feel that there is too heavy an emphasis on technology. You should know that we don't view technology or tools as ends in themselves; we use them as means to educating students. We try to utilize whatever tools are available, and certainly we've been scrambling to get into the advanced technology field because that's where the really powerful tools of assistance are.

As you tour the advanced technology facility, keep in mind that that is a facility that was not approved by our governing agency, the Ohio Board of Regents. It's probably the most important facility in Lorain County today, but if we had waited for the Ohio Board of Regents, we would not have it. Everybody around here realizes that if something is going to happen in Lorain County, it's going to happen at LCCC or somewhere flowing out of there. But that facility is there because we injected ourselves directly into the legislature and succeeded in slipping 5[illegible] million dollars in at the right point in time. Even now that it's in [illegible]e and on line and the Regents are beginning to understand that they should get involved in some way with industry, nothing that we do out of that center is going to be financed or supported by the Board of Regents. Because the center is conceived as a place that tries to provide training to industry when it wants it, where it wants it, and in whatever modules it wants it. It tries to meet industry's needs. Our Board of Regents doesn't feel that's really higher education -- it doesn't qualify for support. I merely mention that because you'd think a state agency would be supportive of something like this, but that represents tremendous risk.

I hope you'll have a fantastic day here.

DR. RICHARD BYRNE

Let me give you my premise first. My premise is that people are all that counts. Okay? People are all that counts. I was raised in a very fundamental Christian group, and I'm a humanist by training, by discipline, by purpose. I paint, I play the piano, I'm interested in art and literature. And I am now a very competent high technologist. I became one in self-defense.

I first took up photography because I had a staff photographer. When I was teaching classic Greek theatre I had a staff photographer and I would say to him, "I would like a picture of the theater with this title floating in the clouds. Very aesthetic -- floating in the clouds. And he'd say, "Well, we can't do that." And I'd say, "Why?" "Well, we don't have an illumitran." I didn't know what that was, and I'd say, "Well, what does that cost?" "Two thousand dollars." Oh God, for a title in the sky! Fine. So I'd write a grant, and I'd get him two thousand dollars.

Pretty soon he'd say, "Well, we can't do that anymore because what we need is a Strobonar Roboflexer 5.8." I didn't know what he was talking about, and I began to be suspicious that he didn't want to do what I wanted to have done. He just didn't want to do it. And so one day in a snit I wrote a letter to Eastman Kodak, and I said, "Send me everything you have in print on still photography and I'll pay you C.O.D." And so it arrived in a big box, forty-three dollars. (Because most of it's free -- I mean they want you to be a good photographer because you shoot a lot of film.) So I bought a Nikkormat, a bulk loader, a hundred feet of film, and I came

in the lab the next Monday and started learning how to bulkload film, starting at the beginning. The photographer came in late, as always, saw me bulkloading film and knew the gig was up. He knew it, and his performance just immediately improved. It wasn't that I wanted to take the photographs myself; I wanted to create results with students. I knew learning theory, I knew teaching, I was committed. I knew what I wanted on the screen, and this technologist was standing between me and communicating with my students. So I became a photographer. Pretty soon I found out it was so easy to do what I wanted that I let him find other employment.

Same thing is true of computers. Five and a half years ago, I had never turned on a computer, I was computerphobic in the extreme. I worked at a communications school at U.S.C. and I regarded myself as a humanist, I thought all the people around me were technologists and social scientists -- you know, with the plastic pocket protectors and the ball point pens and all that kind of stuff. And I felt like the Auslander. I felt like the stranger, the foreigner, the wierdo, and they were all logging on.

Everyone in the school had a computer account, including me. I couldn't log on -- I couldn't turn it on. My account consumed more money each month than any computer account in the school. Think about that a second. I could not turn it on, but my account would consume $1400 a month in CPU time. Why? Because everybody knew I couldn't log on -- they were all stealing my account time. My password was common knowledge. Everybody else knew my password because I didn't. If I had logged on once, I would have said: "What's going on here? Get off my line." But I didn't know how to turn it on.

Finally, I wrote in my journal: Get on line. And a week later: Why don't you learn about computers? And a week later: At least find out your password. It was nagging at me. Is there anything in your life that's unhandled? I mean is there any communication you have not delivered, something you ought to tell somebody and you Have not told them? Go to

the phone, call them, and say: "Mom, I love you," or "Ben, bring back the car tonight!" Deliver that communication. Well I just kept not doing it. I was afraid I would have to lose being a humanist if I began to use technology.

This notion of high-tech people -- I don't know what that means. Is a pianist a high-tech person? A piano is a technology, you bet. You need to know that when you buy a computer it's like buying a piano; it's not like buying a stereo. A lot of people think it's going to get user friendly, and that pretty soon you just turn it on and you just touch the screen and then it will do it for you. There are people who buy pianos just as a kind of living room decoration. But if you want the piano to perform, you perform, and the more you perform with it the more it performs with you and you both get better together, and the more you play the better your piano gets. Okay? I wanted to learn but I was terrified. I had an intense phobia. Then I finally broke through. One day I wrote: Get on line, you jerk! And I underlined jerk and it ripped through about three pages of my journal. Now I was fetishistic about this journal; I mean, this was a white sketch book, and I wrote on it with a Grumbacher pen. I ripped through my journal and I looked at it and I thought: Whoa -- You have a deep problem here.

So I went out that day and I bought my first computer. It was an Apple and I knew absolutely nothing about it. I went into Computerland and the guy said: "Do you want two disk drives?" I said, "Sure." You want an eleven inch monitor? Yeah, right, whatever it is. This guy of course just thought it was great. He said: "Do you want the graphics tablet?" I don't know if you know it, but that thing violates every law there is. I mean, the Fair Trade Commission finally said: "Get that off the market." Everybody who's used it has been rendered sterile. And I said: "Do I want a graphics tablet? Of course!" I bought $6,000 worth of garbage and could not turn it on. And I said to this young kid, "How do I learn to use this?" I was then Dean of the Annenberg school at U.S.C. and he said to me, "Can you read?" I said, "Yeah." And he said, "Well, read the books and do it!" I said thank you.

I'm going to tell you two stories and then I'll get to the premise of the talk. First, I took the thing home and after about four months of working every night I was writing programs like this: 100 PRINT "HELLO". 110 PRINT "RICHARD". 120 GOTO 100. RUN. It would say: "Hello Richard, Hello Richard, Hello..." I mean there's no money in this folks. But that's the kind of stuff I was doing.

Second thing I learned, and this was a breakthrough point. I'm writing a book now called Breakthrough that will be out in the spring -- and I keep looking for breakthroughs as opposed to just improvement. I think improvement is probably bad news. Improvement implies that it will take a long time to do it; but breakthrough means tonight, like RIGHT NOW! You want to break through? Break through now. I think that's possible. Six years ago I was sitting reading in the Apple Soft Manual and there was a long program and I entered it all and I hit Enter and nothing happened. I thought, "Oh no." So I proofread the screen. It looked right to me. CLEAR. NEW. 100...Start over. This time line by line, character by character. It took an hour to enter these 47 lines of text. ENTER. Nothing happened. I turned the page, and on the top of the next page it said, "Nothing happened, did it?" Now, that was their idea of user friendly. My wife reads magazines from the back. She picks up Forbes and starts at the back. I don't know why she does that...it still gets me crazy. But that's the way I read manuals now. I start at the back and I skim rapidly forward looking for surprises.

Now, there are four questions you need to ask and then you need to answer them. I will not answer them for you. I'll give you my answers, but I have no idea what's true for you. Some of you are going to be heavy users of a lot of technology; some of you don't want to use it at all but you don't want to look like a dope. Some of you are here because you have "jerkophobia". It is not computerphobia or technophobia. It's that you don't want to look like a jerk in the school system. When a meeting's being held on high technology, you're there. You're not going to do anything, but you'll show up. A lot of people just want to know enough

to know what it is they don't know.

Here are the four questions. (1) Is anything changing? I talked about this a little yesterday afternoon. But is anything changing? Regarding micros, minis, mainframe, satellite, holography, fiber optics, teleconferencing, networking, and so on. And it's important that you own that change; not that you should know it. You say, "Yes, I know it's changing." You need to own the change. I said yesterday that if you step outside and it's raining, you own the rain. You say, "Oh my god, it's raining!" And then you wait a while or you run, or you do something. A lot of people in education don't own the change. People in business do.

America doesn't want educational institutions to be at the leading edge. What we want in education is stability. We want cultural transmission, we want something that's reliable; we want the schools to be open in the fall. Aren't there companies that won't be here next fall? Aren't there entrepreneurial ventures that are now making $100 million that will be kaputt next September? I worked for the Osborne Company. They were selling 12,000 Osborne One's every thirty days -- 12,000 a month. They grossed $200 million. They made one strategic error by announcing something at a press conference and in thirty days the company went out of business. They went from $200 million a year to zero in April of last year. You think we want schools to do that? We don't want schools to be that innovative. But you do need to figure out if it is changing.

When you fly cross country, how high do you fly? Thirty-five thousand to 40,000 feet, depending on what kind of plane you're in. And what's the temperature up there? About 60 below zero. Or 50, depending on the altitude. How cold is 60 degrees below zero? Very cold. In two minutes your tush falls off. How fast are you flying? 600? 550? 1400? How fast is 600 miles an hour? Very fast. That is what I mean when I talk about not owning it. Stick your arm out for a turn signal. You'll find out what 600 miles an hour is. It'll leap into your head. Furthermore, there's no oxygen up there -- not enough to survive. So just two

inches away is this hostile change-filled, roaring, screaming, freezing environment, and you're sitting there saying, "There's no ice in this drink." Or, "The movie's out of focus, Miss, could you get the movie in focus?" It's called the little picture.

Don't all of you have the little picture that you have to deal with every day? I mean, for first-year teachers, the one thing they don't know about is red construction paper. The first year of teaching elementary school, you don't know you've got to get that red paper right now -- I mean September 1 -- you've got to get that red paper or you have a green Santa. They don't know about that, you see. The experienced teacher makes a list. "Give me red paper, give me five boxes of chalk..." Get your stuff together. That's called the little picture. Educators are consumed by the little picture. And you ought to be because you're supposed to keep the shop running. I'm not belittling the little picture. But there is a bigger picture. I believe society is in fact changing. I think education ought to be preparing us to deal with a changed world.

Now, let me tell you something. Think of some fashion, some clothing style, something that has changed in the last five years. Just anything. What's that? Miniskirts? Are they coming back or going away? They're coming back? I've been on the road, I didn't know. Miniskirts, whites, Michael Jackson gloves -- whenever an idea appears there are people called early adopters. They get it the first time it appears. There are people who love gear, they love executive toys, they love computers, they want the new computer and they want the new portable computer, okay? If you're on that end of the curve, you would have the state of the art if you could afford it. You'd just constantly throw stuff out and get new stuff in.

For every person that's up there in every organization, there will be an equal number of people called "never adopters". Their whole purpose in life is that they're not going to do it. They're not late adopters; they are never adopters. The Amish are not into velcro. And

significantly, they're not going to be. See, this is not casual. They are committed to not using the latest of high technology. That's how they define themselves. There are people whose very being is defined by their non-use of technology. And you've got them in the school system. They are absolutely reliable. If you say to them, "Will you please provide the food?" and they say, "Yes", you can forget it. They will handle it. What about those other people? They think, "Oh God, well you know I got so wrapped up in the program that I just forgot all about the meeting." No food.

There are also people who only adopt after they've watched other people. They wait and watch the early adopters. Does it actually work? I have identical 19-year-old twin daughters named Megan and Heather. Heather is an early adopter. She is crazed: "What is that?" "Let's do that." "Stairs? Let me try stairs." Her body is a wealth of cuts and bruises and scars and so forth. Megan always sat and watched Heather for about a week. And after all the smoke had cleared, then she would just stand up and walk upstairs. She had zero learning curve because she went to school on Heather. Now Heather had all the excitement. Heather had the challenge. Heather had the risk. Heather had the ecstasy. "I walked up the stairs and didn't go to the emergency ward!" Megan didn't have the excitement but she had a lot more security.

Now you need to know that in a school system there's a sort of bell-shaped curve. There are a few early adopters -- I don't know, probably 15 percent. At least 15 or 20 percent, probably more, are never adopters. School systems generally tend to be more conservative than liberal. There are people here who won't do it until it's at Montgomery Ward's or Sears, but microcomputers are now at Montgomery Ward's and Sears. It has reached the mainstream. IBM has a massive advertising campaign to push microcomputer usage all the way through middle America by Christmas. You're going to see a massive ad campaign appear in the next month in conjunction with Procter & Gamble. There will be a massive push on the PC jr as the entry-level machine.

Now if you have people in the school system on both ends of the spectrum, what are you going to do about somebody who doesn't want to play? They don't want to use the technology. I talked to the president of a major bank in Chicago recently. He said, "We have the Prof system." That's the state-of-the-art IBM executive communication system. Fabulous electronic mail. I said, "Oh, I'd love to see it." He said, "No problem. Brenda, get my mail." And his secretary walked in; he doesn't use it at all. He's got it in his office but he doesn't use it. So what are you going to do about people in the school district that don't want to use it?

And by the way, you should not overlook students. I'll give you one of my concluding tips here early: You need to renegotiate your contract with your students. The educational system in America is based on an invalid social contract. The contract says that teachers know and students don't, and that the teacher is dispensing, if not knowledge, at least structure -- a way of knowing. And I'm here to tell you in a technological age that kids learn intuitively and you learn linearly. You are memorizing: "What is it? What's the rule?" That's not how kids learn. Do kids learn to walk by reading a manual? You buy a computer, the first thing you read is the warranty. What do I do when this thing breaks? So the whole time you're working you're getting ready for this thing to break. Kids don't do that. They just push buttons. They learn intuitively. So when I teach, my social contract is that if you teach me a lot that I never knew, you get an A. I don't care what you do on the test. Yes, you can get an A by doing well on the test. But some people can't do well on tests, and if they teach me a lot, they get an A. So when kids realize that I'm telling the truth, they say, "Here. Did you know about this?" And I say, "Yeah, I knew about that." "Oh, damn. Did you know about this?" I say, "No." "Good, that's one!" At the end of the course they're just crazed learners, and of course it becomes habituated and they just run around learning stuff. "What have you got here? Richard might not know that."

If you teach me a little that I didn't know, you get a B. The only way you can fail my course other than just not getting any of the questions right on the test, is if you know things that you're not

telling me. See, this is called the leveling factor. Boils the arrogance out of the undergraduates.

The teacher studies BASIC all summer. Kids know that by lunch the first day. You come back and they're writing nested loops and Pascal. Oh, my god, what's going on? When I see that they know something I say, "It looks to me like you know something. What is it you know that I don't know?" Then they tell me and I say, "I didn't know that." I want to be corrected on the spot in front of the students. Then they get an A. The minute they find out that's the relationship, all of that contention and strife and competition between the teacher and the student disappears. And then people just all cooperate and bring you information and then you share it with the students. If you believe you can stay ahead of students teaching a new technology, you need clinical help.

Maybe you've seen the film from MIT that was produced two years ago about the engineering competition. Well you ought to get it and you ought to look at it and you ought to think about it. Don't show it to your students; just look at it and think about it. They announce a competition each year and for this particular film, the competition is that you need to build a robot that sits on a table, takes hold of a peg and puts the peg in a hole in the middle of the table. Every student has that assignment. One student is on one end of the table and the competition is on the other end of the table, and each robot must try to grab its peg and try to put that peg in the hole in the middle of the table. And the peg that ends up in the hole at the end wins.

The teacher doesn't teach them engineering skills or anything else. The students are given a bag, and in the bag is some cardboard tubing that comes in the center of carpets, two little DC motors, some wire, some string, some glue and some other garbage. The two strategies are offensive and defensive. Some of them build a robot that shoots the other robot's peg off the table before he can reach it, and then the first robot just puts its peg in place. Others have defensive strategies: an enormous metal cowl shields the hole, and then the robot drops in the peg.

They are very inventive. One guy got a plastic squeegie mop that shoots out after the peg is in. The other robot puts his peg in and then the johnny mop knocks it off the table. You see what I'm saying? The invention comes from the students, not from the teachers. Teachers don't know how to handle it. Students come up with bizarre, fantastic technological conclusions and the teachers just sit there and take notes. Then they go write books and get Nobel prizes. So I think we need a new social contract.

I think there are two basic kinds of change in life. We talked about change. The first question was: Is anything changing? I'll list the other questions for you. Is anything changing? One kind of change is cyclical. Cyclical change is seasons and fashions and administrative style in schools. We become more conservative and then more liberal and we decentralize and we centralize -- that's cyclical. It comes and it goes. In structural change, suddenly something occurs. There's a boom, and there's discontinuity. There's a leap up or down to a new level where a new form of behavior begins. When that occurs there is a major change in how life is run. The car is a good example of that. After the car appeared, we never went back to horses. The phone. Television. I believe the microcomputer is one of those transforming technologies. I don't believe cable television is, but I do believe the microcomputer is. I waved this around yesterday -- this is the most important computer that I own. I own a bunch of computers of every possible brand, but this is the one that I can stick in my jacket and carry with me and write and do electronic mail and teleconference and so on. This is transforming. A terminal, a 3270 linked to a mainframe is not transforming. It's an improvement, it's more powerful, but this is a transformation because it's a quantum leap, it's different. You need to figure out is the microcomputer a transformation for you, and then there'll be a new cyclical behavior. Is it significant for you or not? You need to figure out if it's a transforming technology or just a fast typewriter. Some people use a microcomputer and it's nothing but a typewriter that stores information. That's not transforming. See what I'm saying? I believe the potential for transformation of education lies in the use of the microcomputer. My opinion.

Now let me list the other three questions for you. The first question was, "Is anything changing?" Check to see if you can get the big picture once in a while. The small picture is, "Is there ice in the glass?" The big picture is, "My God, we're going 700 miles an hour and it's 60 degrees below zero." What criteria do you apply to figure out if something is real? You read it in USA Today, you see it on television. Does that make it real? You see it in an educational journal -- what makes things real for you? Because your belief is reality, what you believe is what's real for you. So you need to figure out how to test these ideas.

The second question is, "Will the change have any effect on you?" Do you think microcomputers could have any effect on schools? What effect might it have? What might be done with microcomputers that would transform education instead of just fix it up? Drill and practice computer teaching is not transformation. Active learning is -- query learning, where students sit down and play with the computer and they learn something the computer didn't know. Simulations, where you create worlds that did not previously exist. You alter a variable and then you see that world change. What about administration? Could you do a better job internally? Not just the old work, not just the bookkeeping; but couldn't we have a network where when you have a question you type in TCS029 and I answer it that morning? I'm on the source at TCS029 and what you do is log onto the source and type TCS029 HI RICHARD, WHAT DID YOU THINK ABOUT SUCH AND SUCH, and then you hear from me. Does that work or not? Well, go find out. It's five years old.

What else could happen in schools with micros? Could social relations between teachers and students, between students' groups be affected? It's a lot more than saying, "There's no good educational software." You are the educational software. So when you say there's no good software, probably you know. A lot of people are looking around for a disk; stick the disk in and all of a sudden the computer becomes a good teacher. You have to be the good teacher. The computer is a lever for you; it amplifies you. Every technology that we're talking about is like a stereo

amplifier. It takes whatever the signal is, it makes the highs higher and the lows lower. Using a powerful micro as a teach is like sitting on a rocket and lighting it. It will speed you up, so you'd better be sure you're pointed toward a door. You want to be sure you're doing the right thing.

I said last night that if you are disorganized and you use a computer, you will become disorganized at computer speed. And that is true. I'll tell you what it's like. Do any of you have your houses in disarray? Let's suppose that I am going to send a photographer and a reporter to interview you because you've just been chosen Ohio's entrepreneurial technologist teacher of the year. You're the new creative thinker. And they're going to come and take pictures and put you in the Cleveland Plain Dealer next Sunday. Would you do anything about your closets? I mean would you straighten anything up before they came? When you know it's for the record, you get clean. If a photographer came in here wearing a TV news cap and carrying a camera, every person in the room would sit up and get ready to be history. Might be on TV. Every person here would change. If you want to be arrogant and surly, you'll slump down and get surly. It's called getting the way you want to be.

What you should do administratively is get the way you want to be; then put that on a computer and you will be amazed. But you've got to be organized first. I'd say anything you can't do on 3 by 5 cards you should not try to do on a computer. Start with 3 by 5 cards, and figure out what works. To give you an example, there's a very large retail firm that I do some work with and they just automated all of their internal processes: point of purchase, ordering, inventory, everything. They found out there was one mistake in the program and in about an hour there was a hundred million dollar error in bookkeeping. It's like if you're two degrees off course flying a private craft and you speed up, you just get farther off course faster. This company found out there was a little accountant who had worked for them for 20 years and he had always corrected for this mistake. Every week when it came across his desk as $90,000, he'd strike out a zero and make it $9,000. He knew, but he didn't tell them;

he didn't think it was significant. They automated it the way it came to him instead of the way it left him, and within an hour they were on their knees. So you want to be sure the system works before you log on.

The third question is, "Will you have an effect on the change?" Will you -- and I don't mean teachers -- will you personally have an effect on the information age? Will you change the course of it? Can you think of one way in which this group might change the course of the use of technology in education? How about using it to manage schools? Are there any models for the use of computers to manage large corporations or organizations? Are there any models that work? See one thing I think you've got to do is start looking elsewhere than schools. Dallas Garrett said if he had waited for the Board of Regents to act, this Center wouldn't have been built. He didn't break the law. He just considered things entrepreneurially and he thought, "We need a high-tech center. What is a legal way to make that happen before I die?"

You need to think more entrepreneurially. What happens when a college band is invited to the Rose Bowl and they don't have any money for uniforms or air tickets? What do they do, ask for a grant? No. They wash cars, they make burgers, they have pancake fries, they sell whatever, and they go. They go. So if you think you need technology, what you ought to do is tell the kids that you think they need technology and then watch what happens. It needs to be entrepreneurial and legal. Some of you think it's not good public relations to go out and steal computers.

Last question: What should you do right now? Look at the change -- will it affect you, can you affect it? And I'm pushing heavily on personal responsibility: You're the one -- you -- you're it. This whole thing depends on you. Whatever your position, whoever you are, it's got to be personal. This notion of, "We'll all get together and have a conference later on..." That's not how it works.

Five years ago after I learned how to use a computer I went to U.S.C. and I said, "Let's get some microcomputers; let's teach the

students, let's teach executives. Executives need to know how to do this." And they said to me, "Which computer should we get?" This was five years ago. All that existed five years ago was the Commodore, the Radio Shack, one Alpha top of the line box, and the Apple. That was it. They were trying to a.gue and I said, "Who cares? I can't run anything. Let's go; let's just get something." So they formed a study commission. The study commission took its charge seriously. I'm not ridiculing the process, but they were serious and so they'd say, "Okay, let's go with the IBM", and then the TI Pro would appear. I mean before they could get the report typed, a new box would appear. Wait a minute, wait a minute. Aren't micros going to get smaller? Aren't they going to get more powerful? Aren't they going to get cheaper? Then shouldn't you all wait? Sure. Makes sense to me. So when I saw what was going to happen, i went out and i bought some Apples and I started training people, and I formed a company. It was very successful; I had run it for three years and sold my stock before they got their first personal computer at U.S.C. You cannot rely on the system if you think it's critical. That does not mean you can do violence to the system. I'm not preaching anarchy, but you've got to be an entrepreneur.

Now let me give you my closing tips on what you personally can do. One thing you could do is be conscious occasionally. Okay? I'm serious about that. Most of you are so busy you don't have time to think about this. Do you have time to think about this? Do you have time to study the state of the art? What I recommend is five minutes an hour, maybe once a day, maybe twice a day, but not every hour. Take five minutes and say at five minutes to three every day or five minutes to five, or whenever it is, I'm going to have a little pile of magazines here or things that I rip out of the newspaper or something, and I'm going to read them with no distractions. Define the problem you're trying to work on. How can I implement new technologies in Ohio, etc.? And just read for five minutes in an acceptance state. You'll be amazed at the ideas that will come up for you. They won't be in what you read -- it doesn't matter what you read. You can read Better Homes & Gardens if you want, as long as you read.

The second thing you might do: I think you ought to get a coach. No professional athlete would play without a coach. They have coaches who watch them all the time. And we are not accountable; we haven't been humble for years. Have you been humble recently? A few of you, maybe; but a lot of you, once you're the teacher, can't take it. When somebody really starts to drill, you respond, "Sit down." And Marty gets to sit down because you're in charge. Who gets to correct your behavior? How many of you feel you have a coach? You need somebody who can be a peer partner or somebody that you get together with once in a while and say, "This is what I did", and "What do you think", and "How am I doing?" You need a coach in my opinion.

Third tip: I think you ought to be a pillar of fire. Don't do that until you've made your choice, but when you've made your choice, you ought to be committed: Samarai. Have you ever encountered a mother who is infuriated because something happened to her child? My own kids are developmentally disabled; Meg and Heather are mentally retarded. And I've done a lot of counseling with parents on Independent Educational Programs, and I've seen parents show up insane. I mean, they want it to happen. Everybody says, "Find out what she wants. What does she want? Good, that's great. You want a transfer? No problem there." Because anything else is going to be blood in the street. You need that kind of commitment; you need that kind of intentionality. In Akido what you do is create yourself across the room and then you just let yourself do that through the twenty people. But you create it ahead of time. Every Olympic athlete imagines the competition at a world record before they get in the blocks. The hammer thrower does the entire throw and sees the hammer land at a world record before he picks the hammer up. So the end is complete before the beginning. That's what I mean by a pillar of fire.

My last tip is that if you think there's a barrier in front of you, you're kidding yourself. The barrier's behind you. If you turn around you will find there's an anchor; there's something in your past that is rooting you to the ground. There's something behind you that you're

holding on to that you're afraid you're going to lose -- some valuable belief that you'll lose by embracing the new technology. Like, if you learn to use a computer, then you're going to lose your sensitivity. That's not true: you can do both. So what you've got to do is find that fear and then let go of it. The tip is to let go. Don't try to break through the barrier: just let go of the anchor. Did you ever let go of a helium balloon? Do you have to say, "Go up, go up." No. You just let go of it and it goes up.

I'll close with a story. There's an absolutely fabulous story for you in "Butch Cassidy and the Sundance Kid". Remember when they'd been chased for a couple of weeks, and they're chased to the top of a cliff? I think some of you, administrators more than teachers, feel that this is like a pack of hounds after the fox -- my god, which computer do we get? Do we have a lab, or do we have one in each classroom? Do we have equity, or do we have islands of excellence? What do we do? Should we teach programming or computer literacy and what does that mean? I understand all that. So Butch and Sundance are chased to the top of the mountain and all of a sudden the hunters are behind them, and it's all over. And suddenly Butch has a breakthrough. He says, "I know -- we'll jump." Remember, it's 200 feet to the river. "We'll jump." They won't jump -- they'd be crazy to jump. And Sundance says, "I'm not going to jump", even though he faces instant death, he says, "I'm not going to jump". Butch says, "Why?" "I can't swim". Butch says, "What did you say?" "I can't swim." That's the anchor. For you it might be, "I'm a people person, I'm no good at math." Butch looks at him and laughs and says, "Swim, hell, the jump will kill you." Sundance looked up, and he realized that was true -- he was never going to have a chance to swim because he'd be dead first. He laughed, said, "let's go", they jumped and escaped. Now the point is he was not afraid of dying. Just as you are not afraid of computers. He was afraid of drowning. Not dying -- drowning. He didn't want to drown. The instant he realized he would never live long enough to drown, he had no problem. Sounds like teaching school in Ohio. Thank you and good luck.

DR. JEAN MARX

The Revolution in Biotechnology

The technology that I'm going to be talking about is a lot less obvious I think to the general observer than what you've been hearing so far. You can see that computers are all around you, from the 24-hour teller at your bank to the computers that are moving into offices and classrooms. But I'm going to be talking about the revolution in biotechnology. I noticed that the program mentioned something about spare body parts. Forget that. That's really bioengineering, and I don't know anything about that. What I'm talking about is basically designer genes.

Biotechnology is the use of living organisms or substances derived from them to make products of value to humans. The origins of biotechnology are ancient, dating back to the time when our ancestors first began to domesticate animals and grow crops for food, rather than depending on hunting and foraging. The people who learned that you could leaven bread or ferment beer with yeasts, and that other friendly molds and bacteria could help make delicious cheeses, were putting biotechnology to work. The treatment of disease with medicinal herbs is another example.

There have always been attempts to improve on what nature has given us. Dairy cows are bred to increase milk production and agricultural scientists are always trying to increase the productivity and hardiness of plant crops. These efforts have frequently been successful. The U.S. Department of Agriculture spends a lot of money buying and storing excess butter, cheese, and grains. By and large I think most of us would prefer living in a country that produces too much food, rather than too little.

Still there are limits to what can be done by traditional methods. Breeding new strains of animals or of crop plants takes many years. Many times the plant scientist finds, for example, that the genetic crosses needed to transfer a desirable trait from one species to another can't be done because the species simply aren't sexually compatible. The same thing applies to breeding new traits in animals. Moreover, much of the improvement in the yields of our farm crops is due to the widespread use of fertilizers and pesticides, which are costly both in terms of dollars and energy. So agricultural scientists want to find ways to reduce the farmer's dependence on these chemicals.

Medical scientists want to find new ways of diagnosing and treating disease. Most of the progress in medicine has been against infectious diseases that can be prevented by good sanitation and vaccination or cured by antibiotics. The problems that remain -- cancer and genetic diseases, for example -- are much more difficult to conquer.

The early 1970's saw the beginning of a revolution that is giving science and technology unprecedented new tools for approaching these agricultural and medical problems. The revolution started quietly enough with the identification of the first "restriction enzymes". These are bacterial proteins that can split DNA at very specific sites.

At this point we need to digress into the definitions of genes, DNA and proteins. All the physical characteristics of an organism are encoded on the genes, which are the basic unit of heredity. Each gene directs the synthesis of a particular protein. Proteins are the basic building blocks of all cells, and cells are the basic building blocks of all living organisms. It's very much like the alphabet, from which we build words, and words build sentences, and so forth.

Genes, we now know, are made of DNA, or deoxyribonucleic acid. Each molecule of DNA consists of two long chains, which are themselves formed of four building blocks. The sequence of these building blocks

in a gene specifies the structure of a protein. Because of the way restriction enzymes work, scientists found that they could use them to cut DNA from two different sources, and then join them together to form molecules of recombinant DNA. Genes from any source, including those of humans, can be put into a vehicle that can be introduced into bacteria, where the gene will reproduce together with the bacterial genes.

It's a bit hard to convey just how revolutionary this was because 15 years ago it was extremely difficult to isolate genes and study them directly. Today a molecular biology lab can find whatever gene they want within six months, isolate it and determine its entire structure. This has given scientists a really remarkable tool for studying how all living organisms work. But more than that: Because genes can be put into bacteria and multiply there, you can get large quantities of the pure gene. Even a human gene will work in a bacterial cell. So this gives you a way of making large quantities of rare materials. The bacteria serve as small factories for making a large assortment of materials that can be used in medicine and agriculture.

The first products we will see are going to be fairly humble. Bacteria can be modified to produce large quantities of vitamins and amino acids for feed supplements, for example. They may also be a source of a new type of drain cleaner. A Maryland company has begun marketing a drain cleaner that contains a bacterial enzyme that can dissolve hair. It takes much longer than Drano to work, but you don't burn yourself. They are not currently using the new biotechnology to produce the enzyme, but they might if the product is accepted and regulatory obstacles do not intervene.

Genetically engineered bacteria are also beginning to provide large quantities of medically useful substances that were previously in short supply. Human growth hormone is one that should be of great benefit to individuals whose growth is stunted because they do not produce enough of the hormone. Until the bacterial product became available the

growth hormone for treating these people had to be extracted from the pituitary glands of cadavers; it was scarce and therefore very expensive. Animal growth hormones were not effective in human beings. Even though we knew how to cure these people's growth defect, there simply wasn't enough of the product to go around.

Despite all this, investigators are well on their way to developing methods of putting new genes into plants. Bacterial production has also greatly increased the availability of human interferons, which are natural virus-fighting agents. A few years ago they received a lot of attention -- possibly too much -- because preliminary trials had shown that they could also halt the growth of some cancers. There were suggestions that because the interferons were part of the body's natural defenses they would have fewer toxic side effects than conventional chemotherapy or radiation treatments.

However, studies could be performed with only a few patients because the interferons could only be prepared from human cells. Not only were they in short supply, but the preparations were also so impure that it was not possible to tell whether the benefits or side effects of treatment with the materials were due to interferon itself or some contaminant. Now wider trials are being carried out with pure human interferons made in bacteria. Some cancer patients seem to respond, although not dramatically. However, the patients often experience the same side effects, including nausea and hair loss, seen with chemotherapeutic drugs. It is still too early to draw any final conclusions about interferon's cancer-fighting potential. But they may be effective in fighting some of the viral infections to which cancer patients are prone.

Introducing new genes into bacteria or otherwise altering their genetic qualities is fairly easy. Using the new technology to alter the genetic make-up of agricultural crop plants is more difficult but is receiving a great deal of attention. The goals include introducing new genes that will make plants resistant to disease or herbicides,

improve their resistance to stressful conditions such as high salt concentrations, drought, heat, and cold, or improve either the quantity or quality of their yields.

Much basic research will be needed before most of this can be accomplished. Plant biochemists do not fully understand the basic biology of most of the traits that they might want to manipulate. As in the case of bacteria, characteristics that require the operation of just a single gene will be the easiest to manipulate. Herbicide resistance is one possible example. Investigators at Michigan State University have recently found that resistance to the herbicide atrazine is caused by a change in just a single gene.

Another potential manipulation of the plant genome that has been receiving a lot of attention is the introduction of nitrogen-fixing genes into crop plants in the hope that they might make their own nitrogen fertilizer. Legume crops such as soybeans and alfalfa carry on their roots bacteria that fix nitrogen. The bacteria convert atmospheric nitrogen gas, which cannot be used directly by plants, to amonia and other forms of nitrogen which can. Plants such as corn, however, do not have the nitrogen-fixing bacteria and must be given large quantities of commercial nitrogen fertilizers to produce high yields.

The idea is to transfer the nitrogen-fixing genes directly into corn plants where they could work internally. There are a number of reasons why this is going to prove very difficult. The nitrogen-fixing genes are complex; some seventeen different genes are required. Moreover, one of the key nitrogen-fixing enzymes is poisoned by oxygen, and plant cells make oxygen. And finally, even if the genes do work in plant cells, they take a lot of energy to do their job. So you may make plants that make their own nitrogen fertilizer but they don't have any energy left over for making ears of corn. That wouldn't be particularly useful to the farmer.

One such method uses the Ti plasmid, which was originally found in bacteria that cause plant tumors. The bacteria essentially inject the plasmid into plant cells where the plasmid genes cause the tumorous changes. Investigators have learned how to change the plasmid so that it can still transfer genes without the ill effects. They have also shown that the modified plasmid can be used to transfer genes into cultured plant cells from which whole plants can be regenerated. The applications of the transfer method are currently limited because many important crop plants, especially cereals, cannot yet be regenerated from individual cultured cells, although this may yet be achieved.

Researchers are now able to transfer genes into animal cells by a variety of methods. The major goal of most of these experiments is to study how genes work: what turns them on when they should be on and off when their products are not needed. But the methods also have a potential application in gene therapy for hereditary diseases. The most spectacular example of this was just done a year or two ago. What is done is to take a clone gene for growth hormone (because the gene is readily avilable now) and inject it into fertilized mouse eggs. These eggs are then put into foster mothers where they develop into mice and are born in the normal way. The mice who have extra copies of the growth hormone gene turn out to be 50 to 100 percent bigger than mice usually are. You might call them Mighty Mice. People are probably already working on ways to use this kind of technology to breed bigger cattle, for example, or pigs. The mice don't seem to eat more, incidentally, which would also be an advantage if you could do this and get beef cattle that are 50 percent bigger than normal without actually putting 50 percent more feed into them.

Gene transfer might eventually be used in human medicine to replace a defective gene -- one that causes serious disease -- with a good new gene. Certain anemias would be especially good candidates for such corrective procedures. Sickle cell anemia, for example, is caused by a single faulty gene for making hemoglobin, the oxygen-carrying protein of red blood cells.

Conceivably it would be possible to transfer a new gene into a patient's bone marrow cells, where hemoglobin is made, and to put the bone marrow back into the body. If there were a way of getting the cells with the good genes to take over in order to make enough hemoglobin to improve their condition, this could essentially be a cure for sickle cell anemia. There are other genetic diseases that might be amenable to this. Notice the difference here, though. In this case, investigators are talking about putting the gene into bone marrow cells to help the patient, but it would not be transmitted to offspring. In the case of the mice, however, these animals are permanently genetically altered and will transmit the new trait to their offspring.

Finally, I want to say a few words about monoclonal antibodies. Antibodies are proteins and an essential part of the body's defense mechanisms against disease. The immune system produces them in response to such foreign invaders as bacteria and viruses, which the antibodies help to destroy. They do this by recognizing and binding to whatever agent triggered their production. (The triggering agent is called an antigen.) Because antibodies are very specific in their ability to recognize antigens, researchers have long used them as valuable analytical and diagnostic tools.

The standard method of making antibodies has been to inject an animal with whatever material you want to detect and then harvest the antibodies from the animal's blood. But each batch prepared in this way was a complex mixture of many different antibodies, even though all of them recognized the original immunizing agent. Moreover, the preparations could vary from batch to batch.

Monoclonal antibodies are made differently. The production starts by injecting an animal (usually a mouse) with the antigenic material. Then the animal's spleen, which contains the antibody-producing cells, is removed. Antibody-producing cells do not ordinarily grow in culture, but can be made to do so if they are first fused with a type of tumor cell that is capable of growing indefinitely. Each hybrid made in this way

creates a single type of antibody molecule, which is called a monoclonal antibody. Virtually unlimited amounts of the antibody can be obtained from the cultured cells and the user does not have to worry about variation from batch to batch.

As I have mentioned, monoclonal antibodies specifically home in on and bind to the material that elicited their productions. This makes them very valuable diagnostic tools. Clinicians are already beginning to apply them to cancer diagnosis. They can be bound to a fluorescent dye or radioactive compound and used to check for cancer cells. Ultimately the antibodies might also help to increase the selectivity of cancer therapies, many of which are now limited because they kill normal cells as well as those of tumors. It may be possible to use the monoclonals to carry toxic drugs or radioactive materials directly to cancer cells, killing them without destroying normal cells.

Many of the applications of the new biotechnology that I have described are still in the future. Nevertheless, there is a lot of money being invested in them. A new industry is springing up as biotechnology companies are formed almost daily. In addition, well-established chemical giants such as Monsanto and DuPont are setting up multi-million-dollar centers for biotechnology research. Some of the smaller companies in particular may not survive, but the amount of effort indicates a general view that biotechnology will eventually be very lucrative.

DALLAS GARRETT

This has indeed been a very exciting year and a half for Lorain County Community College. I would say that the folks here had no idea what was really coming and I would guess that I wasn't sure just how all of this would be accepted in the community. We have been quite positively accepted, I would say. Our enrollments have been excellent and we are now just 40 to 50 percent of where we'll be in the next couple of years.

It hasn't been without some pain; more than likely, the change of moving from very traditional programs into some relatively up-to-date high-tech programs will be a difficult one. I know that for us to stay on the cutting edge we can't be too satisfied with where we are today. We have to evaluate almost on a daily basis, and we should back up and recognize that almost everything we have today wasn't even available a year ago. That's how fast we're moving. We must upgrade continually and it's painful.

You have to get into a little different mode here. My idea of an ideal faculty member is one who works out of magazines, periodicals, and throws everything in the trash on the way out of the classroom. Doesn't even keep a filing cabinet. I know school presidents who now demand that. It's tough to accept. I've worked beside teachers who for 20 years have taught what they were taught. After a year or two they are out of date. We can't afford to proceed in that direction here, and we're not going to.

We have made some radical changes. We disbanded some programs that are rather traditional and are still in operation in probably

95 percent of other schools. We don't have them. We turned everything upside down and started computer-aided design, computer numerical control, computer systems maintenance, robotics and microelectronics. I started four out of five of those 17 years ago and I took a lot of flak then.

I'm going to get off the philosophy and tell you about what we've done. We did start those five programs and we started another half dozen certificate programs in the engineering and computer technologies division. We also have the high-technology center now, called the Advanced Technology Center. And that center is geared to meet predominantly the non-credit needs of business and industry. One-day seminars, one week, one month, six months -- whatever is necessary.

I've helped a lot of colleges start numerical control and CADCAM. A gentleman invited me recently to see a college where any student who comes through the doors can start the course of their choice the day they walk through. Credit, non-credit, audit or whatever. Twenty thousand non-credit students and ten thousand credit students. Pretty exciting. And they have taken whatever steps are necessary to insure that can take place.

We're going to be looking into some pretty creative things here in the future. What we're going to show you today are about ten labs that relate to these new programs. We've purchased about a million and a half dollars worth of equipment, and I would say we've acquired something in the neighborhood of an additional five or six million in the last year. We bring a salesman in, give him the whole pitch, show him what we're interested in, and then explain that it was nice talking to him, we like his product, but we don't want to buy it. And sometimes you don't get much cooperation after that point. But we know that a good portion of these products are going to be outdated a year from now. We'd rather have it on loan and then give it back and take their latest and display it for them. We're working on things like that.

We're open 24 hours a day for CAD and CNC. We're running a JTPA program at night, after midnight. Of the first 18 placements, 14 had been on welfare. We're going to expand that area, I'm sure. We're running our third and fourth CAD and CNC model and we think it's going very well. We're trying to find people who are on the street, unemployed, and to do a whale of a job for them in a short length of time.

The thing that's going to make this all work is our job placement effort. A lot of people talk about bringing students in, they talk about recruiting, they talk about what they're going to do in class. Then they say, "You're on your own. Find a job", or "Go up and look on the job board." We're going to get far beyond that. We're going to put together a network and I've had tremendous cooperation from the placement department. It's looking good. We are already finding so many jobs that it's spooky, even in this area. We've had the forty-sixth person go to work in CAD and we won't have a graduate for another year. CNC is also opening up.

As I said, it's been a very exciting year but it hasn't been without difficulties. People are pretty comfortable here; and I think they'll be a whole lot more comfortable when they see the results that we're going to achieve. I think you're going to be extremely pleased with the kind of equipment you're going to see.

ALLAN McLEOD

Did you see how young those LCCC students were? I looked at how young they were and I felt archaic, and I would like to talk a little bit about that -- not about my archaic feelings but about the implications of that. To do a synopsis, I don't know how you do it, but after this conference I feel like a Cleveland sausage that has been stuffed with technology. I will go home and probably by tomorrow a solid theme will clearly have emerged.

It's very hard to be experiencing something and at the same time to put it together in a way that's absolutely meaningful. I've been asking people and doing little surveys during the conference in order to try and do this. I was surprised -- I was shocked -- yesterday when Mr. von Puttkamer began to speak. I was shocked because I thought I was approaching what I felt would be a very alien situation. And that seems to be the first theme that emerged for me. I was shocked by his humanitarianism. Not that I didn't think that people in technology were humanistic, but I was struck by his real concern. I'm a person who evaluates things strongly because I feel deeply, and I had the sense that he was grappling with some very serious problems.

He told us about space stations and I found that fascinating. He told us about space at different levels. But he also began to talk about what happens. And as an analyst I was interested in what happens when you take people with a caveman mentality (because we haven't really changed in evolution a great deal) and you begin to give them space age technology. I was interested in that because I do not live and deal in a rational

world -- not in the field of psychoanalysis. I'm convinced that man isn't so rational. It makes me afraid when I think that man thinks of himself as a totally rational animal. It's not my experience of mankind. And I saw him grappling with this. He talked about setting priorities. He talked about our entering the Third Millenium, while four-fifths of the world's population is starving. The Pope spoke about this same thing when he was in South America. He saw this as the greatest single danger that we live with and I began to feel closer to NASA and to the kind of things that they were grappling with because I realized we're not so different. He talked about synergism -- that's a group therapy word, by the way. He talked about the whole idea of energy and of building, and I heard that idea over and over again.

Another theme: Mr. von Puttkamer talked about the fact that we are no longer collectors of information. We shouldn't just be teaching information. We are teaching how to use inquiry and knowledge, and the whole idea of education is changing. That was said over and over again. We then went on to hear a little about Logo, and some touched on sex differences in the approach to technology -- something I know I'm going to spend time with as an educator. I happen to work in a school where our students are gifted and we, too, are facing the problem that many of our female students are avoiding some of the high-tech experiences. That's something I can relate to. It's certainly something that we're going to have to grapple with.

Dr. Demers showed us high technology in the form of computer graphics. Last night at 4:00 a.m. I think I saw those REM eyes. When I went to bed, I pictured the whole Contact commercial -- you know, with the Contact clearing the nasal passages. I'm never going to watch the Super Bowl in the same way again, because now I'll know that's a computer picture up there. I feel like I've learned something. And yet it left me feeling poor. Although I was fascinated by it, I had the feeling that we in education won't be able to afford that. We're going to get it far

down the pike. It bothered me because the people who will use that will be in advertising on Madison Avenue. We're going to have to compete with a very expensive high technology out there when we will not have that kind of high tech in schools because of its expense. But that feeling was slowly diminished by that disk. The laser disk I think was something that I could see us using and I really got excited about that.

I began to feel closer when Dr. Bondurant spoke about NASA because I realized that NASA and the schools are not so different. We're both in the knowledge business. We do not make profits. We are more alike in some ways than we are different. And I think that we can begin to build a relationship with institutions like NASA and other organizations. I was struck by something that we have not tapped into. We have not done a lot of work in getting our people out to workshops. I would like to see NASA people coming to Hunter* and I would like Hunter people going to NASA. I think we need that; very exciting stuff.

Dr. Byrne -- what can I say about Dr. Byrne? He's into change. He talked about it and he said that we must decide if the world is changing. I don't think any of us who are in the information business can say no to that question. Things are changing. And I think we're going to have to be a part of it. The question in my mind -- because I've spent my life helping people to change -- is how do we do it as human beings? You know on one hand what we see here is vast change and yet I can show you hundreds of studies on stress and change and what it does to people. We can't just change. You can't reason somebody out of what they haven't been reasoned into. I happen to have just done something two weeks ago that exhibits change, and I think it helped me relate to what Dr. Byrne was saying. I did a triathlon. If I had told my friends in the analytic community 15 years ago that I did a triathlon I'd be in a white coat today. They would

*Hunter College Campus Schools, New York.

assume I was in a manic stage and that I was totally insane. The whole concept of what is possible for human beings has changed since then, and many people are doing it -- nothing that exceptional about it. I've talked with runners about marathoning, and it's the same thing. We have to begin to change what we look for and what we can do. We can do it.

The whole idea of getting a coach -- good idea. I think we need coaches. I think we need mentoring. I think one way that you become a mentor to other people is to have a mentor yourself. It's an induction downward, one of my favorite thoughts. I have a colleague who agrees with Dr. Byrne. Dr. Byrne said that we cannot rely on the system to change. My friend says it differently. He says the problem is that institutions are not good parents or families, and we want them to be. I think we must work within an institution but I don't think we can wait for it to do for us. So I have to agree with that.

I treat several patients with multiple sclerosis, and so I was absolutely fascinated by Dr. Marx's talk. I made a link and I'm sure many of you did, between what is happening in agriculture, the idea of self-fertilizing plants, and the question that was asked yesterday about four-fifths of the world starving. The whole auto-immune sickness area is one that we're just beginning to touch on. The idea that bacteria can work for us -- I think what was interesting about that presentation was it was stated so low key, and yet I felt the awesomeness of biotechnology. It's an awesome topic and it's one that I think is going to be a multidisciplinary topic.

At NASA we saw cyclotrons. If it hit me I wouldn't have known what it was several days ago. We saw wind tunnels, we've seen robots. We've been bombarded with new space age technologies and yet we have stone age mentalities. Man has not evolved a great deal. It is hard for us to go through change and yet we're being continually bombarded, and I started to think: "What can I do in terms of bringing it together",

because I think we must begin to cope with it.

As a practicing school person, what are some of the things that might help in beginning to approach technology? I think we must begin -- and I think I learned this here -- we must approach technology as a little child. And the older we are, the more we must approach technology as a little child and by doing so, what we are doing is regressing. I could feel it. And in being regressed we must again be dumb, inadequate and ignorant. Those are feeling states, and if we can tolerate those feeling states, I think that we can move ahead. If we feel them and move ahead, then we're growing. If we feel them and stop, then we're acting foolishly. So the real issue -- and this was alluded to yesterday -- is that we must begin to feel things to move ahead. We must feel inadequate in the face of very young people who know a great deal. I don't think it's just a matter of seeing change. I don't think human beings do that.

I happen to have the opportunity of carpooling with the president of an advertising firm and I said to him one day, "You make decisions on any single day which could cost you your job. How do you do it?" School superintendents have to do this, and other people who must make critical decisions. I said, "How do you do it? How do you sleep at night?" And he smiled and said, "You know I brought in a consultant to answer that question because I found I was frozen, I couldn't move. He told me that every two or three months I should interview for a job, and I should always have another job on the line." I think what we have to do is know the options and the possible escape routes. In treating people, I see people change. Sometimes they change when they're very frustrated, sometimes they change when they're feeling very good about themselves. But for the most part real change takes place in an S-shaped curve, when people feel safe. And I think what we have to do is go back to our schools and find a way to make ourselves feel safe enough so that we can begin to make the changes that we have to make. You don't change people by putting them on the spot. Someone said in-service courses are one beginning way. I think we have to

decide with our colleagues how to be safe, so that we can begin to explore and to go through what I think is going to be a regression for many of us.

Another thing I want to tell you is that we're empowered. We live in a world of technocrats. I think if you know people who are involved in technology, they will tell you they don't know. But there is a perception on the part of school people that technocrats know. I happen to work with some business people and there is a sense that big companies know. Big companies don't know. They don't know any better internally than we know in schools. I remember asking the director at Hunter, which is a nationally known school, why we don't bring business in more. He said, "We don't bring them in because they'll absorb us." He was honestly afraid that the power of business -- particularly in Manhatten -- would come in and take over the school. I don't know that that's a rational response. I understand where it comes from, but the sense is that somehow they are perfect, they know the answers and we don't know. That misconception is keeping us from entering into the relationship that the F.E.E. conferences show clearer and clearer to be necessary.

Let me tell you something: many times business people are afraid of educators. One of the reasons we get hostility is that we're powerful to them because they remember being children in schools. We are more powerful than we give ourselves credit for. Watch people go into the principal's office. They are absolutely reliving a childhood. I don't tell you that so you can pick on business people. I tell you that because I think you're more powerful than you think you are. And I think failure to realize that power is one of the things that keeps us from moving ahead.

We must establish a new contract. We must change the way that we interact with our students. I happen to like the concept of a community of scholars and I think that's what we're talking about -- bringing people together to learn together. I also believe that we must be significant to the people we teach. We must be significant people. I've been counseling now for 23 years, and I can tell you that, increasingly, people in our

schools do not have significant adults in their lives; and because they don't have significant adults in their lives, they're lacking. You can have all the knowledge in the world but if you can't form a relationship or a cooperative venture or speak to people in a way they can hear it, then they will not move ahead. And that's what we can do. We must immerse ourselves in our topic and in our fields. But I think it's also important that we begin to teach kids by being real. Analysts call this being identification objects, mentors -- use any word you want, but it's the way kids will grow. Think back to the teachers who most influenced you, and you will find they are the people you've had relationships with. And those relationships are key. To be in a relationship with the exchange of words and learning is a very powerful action.

The last thing I want to leave you with is what I think is the single most detrimental thing that keeps educators from moving ahead. We allow ourselves under the guise of intellectualism to indulge ourselves in self-attack. We are the most self-critical of professions. We also allow the outside community to be critical of us, and then we freeze up. The communication pattern that I've observed among educators travelling around is that they're very honest. My impression is they're very caring, and they're a lot more dedicated in most cases than the media would lead us to believe. Educators sometimes tend not to be clear in what it is that they do because education is a tough thing. Then they attack themselves for it. They freeze up and fail to move ahead. Let's stop attacking ourselves. I think what we need is to make ourselves increasingly safe and to move into the field of technology. I'm going to begin to cope with it. It scares me to death, but I think it's necessary.

FUELING THE EDUCATION EXPLOSION

Participating Organizations

Akron Public Schools
Athens City Schools
Avon Lake City Schools
Bay Village City Schools
Beachwood City Schools
Berea City Schools
Brunswick City Schools
Canton City Schools
Cincinnati Public Schools
Cleveland City Schools
Cleveland Foundation
Cleveland Heights-University Heights City Schools
Cleveland State University
Columbia Schools
Columbus City Schools
Crooksville Schools
Cuyahoga County Board of Education
East Cleveland Schools
Elyria City Schools
Erie County Schools
Euclid City Schools
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First Congregational Church, Akron
The Foundation Center
Gahanna-Jefferson City Schools
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Hamilton County Schools
Huber Heights Schools
International Platform Association
John Carroll University
Kent State University
Lake County Schools
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Marion City Schools
Martha Holden Jennings Foundation
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Pickaway-Ross Vocational Center
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Portage County Board of Education
Positive Education Program

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South Euclid-Lyndhurst City Schools
Southwestern Schools, Grove City, Ohio
Toledo City Schools
Tri-County JVSD
Tri Rivers JVPS
Trimble Local Schools
University Circle, Inc.
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CLEVELAND HEIGHTS-UNIVERSITY HEIGHTS SCHOOLS

Widely acclaimed for its academic programs, Cleveland Heights-University Heights perennially places among the top ten districts and private schools in Ohio in the number of National Merit Scholarship semi-finalists. The district's music program is well known, and more than a dozen Heights High graduates are now with symphony orchestras. The district offers an integrated, structured program for gifted and talented students from pre-school through grade twelve.

The schools enjoy outstanding community support, with the second highest property tax rate in Cuyahoga County. The racial, ethnic and religious diversity of the district is emphasized in the high school's multi-cultural center, which brings in dignitaries, resource people and displays in an effort to promote understanding and appreciation of one another.

Other programs include an elementary "magnet" school featuring individualization with emphasis on math and another magnet featuring traditional education with emphasis on French, Spanish and computers; an alternative school program at the high school for students with "freer" learning styles; programs within the district and in cooperation with other districts for vocational education and education of the handicapped; a wide range of sports and extra-curricular activities; pre-school programs through the Community Service Department; extended kindergarten, an all-day program for the children of working parents; and a comprehensive adult education program.

The district serves University Heights, most of Cleveland Heights and a small portion of South Euclid; 1 high school (grades 10-12), 3 junior highs, 10 elementary schools; enrollment 8,500, modest decrease over next five years; 400 teachers; pupil-teacher ratio approximately 20 to 1; 72% of graduates go to college.

OHIO SITE, EDUCATION POLICY FELLOWSHIP PROGRAM

Institute for Educational Leadership

The Cleveland program is the first urban, non-capital EPFP site and is funded by the Cleveland and George Gund Foundations. The site was established in 1976 and is designed to strengthen educational leadership in local school districts, human services agencies and institutions of higher education.

The education component includes sessions on foundation support for education and educational change and on the policy process as viewed by advocacy groups, administrators, public servants and the business community. Other themes include issues of higher education design, school desegregation, women in leadership roles, delivery of human services and the politics of education.

Training activities include a site visit to Columbus to study the legislative process and the perspectives of legislators on education issues. In addition, EPFP hosts several seminars annually to provide the current Fellows with an opportunity to meet the Cleveland alumni/ae and to discuss policy issues with Cleveland sponsors.

The Cleveland site is affiliated with the Shaker Heights City School District. The Ohio site coordinator is Dr. Mark Freeman, Director of Research, Development and Evaluation for Shaker Heights City School District.

CENTER FOR THE STUDY OF INDIVIDUAL DIFFERENCES IN LEARNING AND INSTRUCTION

The Center for the Study of Individual Differences in Learning and Instruction was established in 1980 within the Cleveland State University College of Education. It functions as a forum for bringing together college and university faculty with interests in the cognitive, affective, social and physical differences among learners that influence the nature and effectiveness of their educational experiences. Issues identified for emphasis may be based in a single area of study, or may be interdisciplinary in character; may vary on the continuum of basic to applied research; and may variously combine programmatic research, evaluative and developmental emphases. A special focus is directed toward study of those problems characteristic of the urban environment.

The Center is a loosely coupled organization designed to provide leadership in the delivery of support services to faculty. The Center is not an administrative unit, but carries out its activities within the existing departmental structure. Sponsored activities have included a series of seminars in the new methodology of meta-analysis and a colloquia series featuring faculty research on such topics as feedback in counseling, learner performance across the life cycle, learning profiles of low-birth-weight children and reader literary response patterns.

UNIVERSITY CIRCLE, INC.

University Circle is a unique blend of cultural, educational, medical, religious and social service institutions situated on five hundred acres of Cleveland's East Side.

University Circle, Inc. is the planning arm and catalyst for the Circle. It accomplishes tasks no single institution could do on its own, and derives its strength from the organizations it serves. Its commitments include planning and area development, acquisition and improvement of property, parking and busing, public safety and security, community and institutional relations and the preservation and enhancement of the Circle's natural beauty.

One of University Circle's commitments is to help school districts develop their concepts into programs.

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